ILLUMINATING ENGINEERING

MAY 1952

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THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

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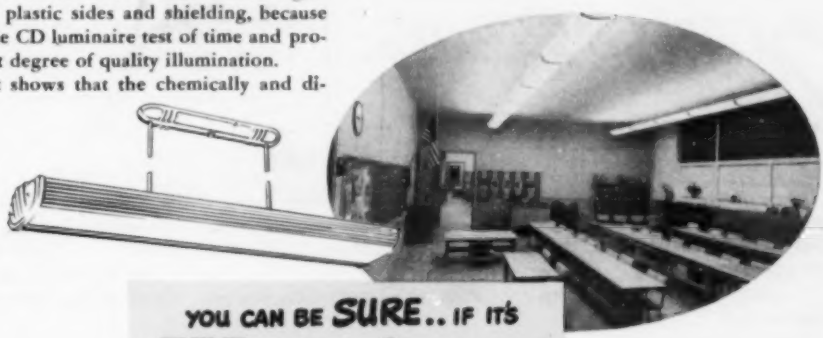

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ENGINEER: Thompson Engineering Company, Boston.
ELECTRICAL CONTRACTOR: Norfolk Electric Co., Boston.
AREA: Approximately 2,400 square feet.
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10 2'-9½" x 8'-0" each w/3-96T12 slimline lamps.
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WATTS PER SQUARE FOOT: 2.9 approximately.
AVERAGE INTENSITY: On table tops, 75 footcandles in service. Average over room, 57 footcandles in service.
BRIGHTNESS READINGS: Walls .045 candle per square inch. Floor .019 candle per square inch. Table top .069 candle per square inch. Fixture—Across lamp axis: At 45°, 0.72 candle per square inch. At 30°, 0.29 candle per square inch.

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ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

MAY
1952

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No. 5

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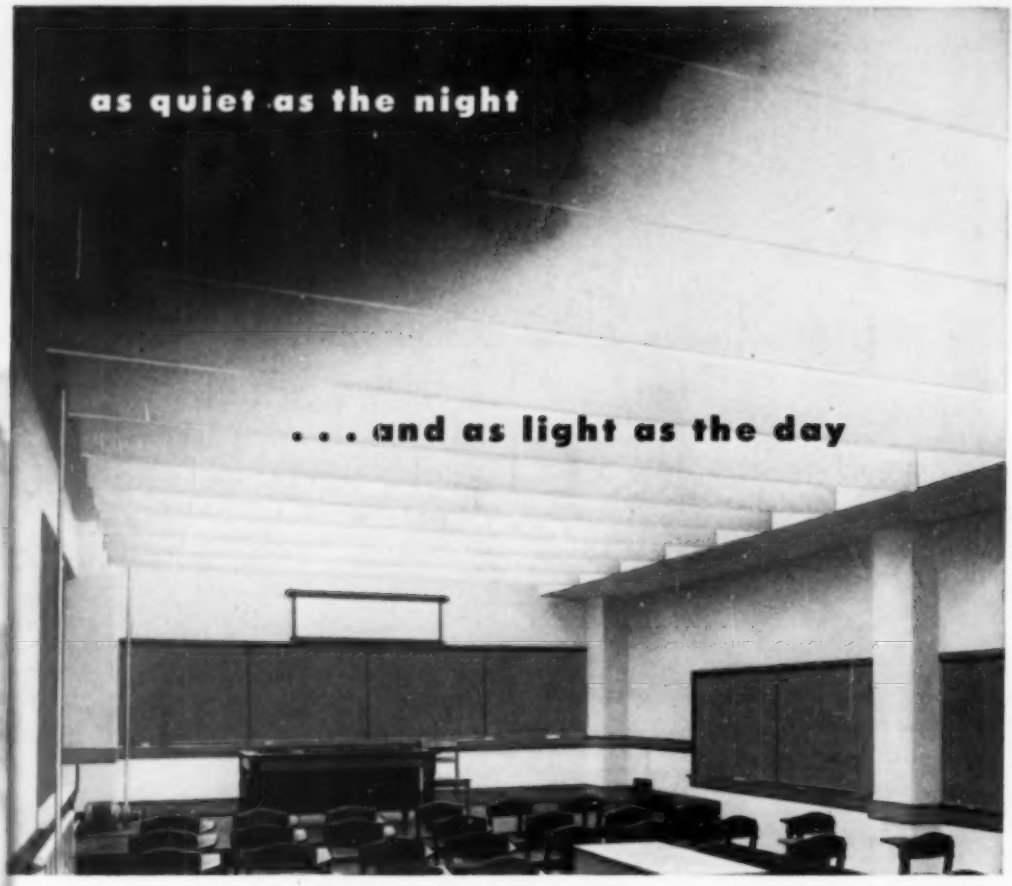

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I.L.E. Gold Seal Awards

The Winners!

From 480 entries, twenty-three outstanding lighting installations, listed below, emerged as top winners of the coveted Gold Seal Award in the Merit Award Competition sponsored by the Fourth International Lighting Exposition (Cleveland, May 6-9, 1952). Over 200 other entries won the competition's Merit Award.

Gold Seal Winners covered a variety of lighting applications — stores, schools, industrial plants — even a freight terminal. They were entered by contractors, lighting specialists, utility men, architects and owners. From whatever field, however, they indicated that professional planning for good visual environment is the accepted practice for successful installations.

Winners—Owners and Users

GEORGE E. PIEPER, Metals & Controls Corp., Attleboro, Mass. With: Donald W. Somes and Ernest J. Precourt.
Industrial Plant—Entry No. 290 (page 238)

W. HENSCHEL, Port of New York Authority, New York, N. Y.
Ramp Roadway—Entry No. 481 (page 237)

CARTER LEWIS, Union Electric Co. of Missouri, St. Louis, Mo. With: Joseph Bettendorf.
Super Market—Enry No. 542 (page 247)

JOSEPH R. BEHAN, Central National Bank of Cleveland, Cleveland, Ohio
Drive-in Bank—Entry No. 575 (page 241)

Winners—Electrical Contractors

H. G. HRIVNATZ, Houston Lighting and Power Co., Houston, Tex. With: J. S. Copeland Electric Co., W. H. Atkinson, Graybar Electric Co., Brochstein's, Inc., R. F. Taylor, Sakowitz Brothers.
Lighting a Girls' Shop—Entry No. 177 (page 241)

LYNN R. KESTENHOLTZ, Lansing Electric Motors, Lansing, Mich.
Office Lighting—Entry No. 244d (page 246)

GEORGE E. PIEPER, Metals & Controls Corp., Attleboro, Mass. With: Donald W. Somes and Ernest J. Precourt.
Industrial Machine Shop—Entry No. 284 (page 242)

HAROLD H. LUNDBERG, Wadeford Electric Co., Chicago, Ill.
Psychiatric Hospital—Entry No. 420 (page 239)

Winners—Distributors' Lighting Specialists

HARRY F. GILL, Graybar Electric Co., Newark, N. J.
Field House Lighting—Entry No. 256 (page 247)

W. E. WATSON, Graybar Electric Co., Detroit, Mich.
Furniture Store—Entry No. 267 (page 242)

GEORGE E. PIEPER, Metals and Controls Corp., Attleboro, Mass. With: Donald W. Somes and William J. Metters.
Machine Shop—Entry No. 287 (page 240)

THOMAS J. FIPER, Westinghouse Electric Supply Co., Omaha, Neb.
Street Lighting—Entry No. 334 (page 244)

J. E. DONALDSON, General Electric Supply Corp., Pittsburgh, Pa.
Office Lighting—Entry No. 432 (page 239)

Winners—Utility Representatives

JAMES F. FINN, Detroit Edison Co., Detroit, Mich.
Machine Shop—Entry No. 187 (page 244)

VINCENT D. MITCHELL, Rochester Gas & Electric Corp., Rochester, N. Y.
Bank Lighting—Entry No. 230 (page 237)

ROGER W. RENKEL, Union Electric Co. of Missouri, St. Louis, Mo. With: E. W. Stohlmann, Jr.
Railroad Freight Station—Entry No. 233 (page 238)

DUNCAN PRESTON, Detroit Edison Co., Detroit, Mich. With: Floyd Sell.
Lighting for Judging Fur-Bearing Animals—Entry No. 294 (page 246)

RICHARD A. MASTERSON, Public Service Electric & Gas Co., Plainfield, N. J. With: E. T. Brown, Architect.
Classroom Lighting—Entry No. 364 (page 243)

HARRY L. NICOL, General Electric Supply Corp., Detroit, Mich. With: Larry R. Nall.
Woman's Accessory Shop—Entry No. 407 (page 243)

Winners—Architects and Consulting Engineers

JOHN D. PERRY, Delbert K. Perry, Architect, New Britain, Conn.
Art Gallery—Entry No. 227 (page 245)

CHARLES S. TELCHIN, Telchin & Campanella, New York, N. Y.
Jewelry and Silver Shop—Entry No. 479 (page 240)

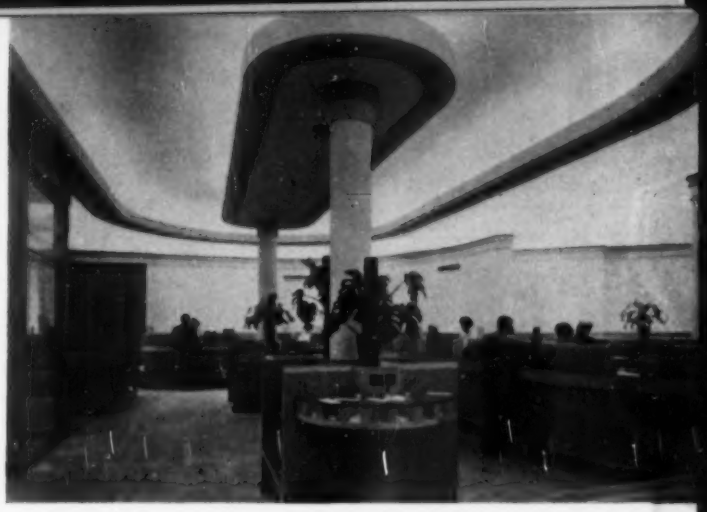
HERBERT A. DELIUS, Delius & Thomas, Engineers, San Francisco, Calif.
Bank Lighting—Entry No. 489 (page 245)

L. RALPH BUSH, Atlanta, Ga.
Public Library—Entry No. 530 (page 246)

JUDGES of the I.L.E. Merit Award Competition, pause in their work of examining entries (a few shown in the background). They are, in the usual order, Berlon C. Cooper, *Electrical Construction and Maintenance;* Chairman Carl W. Zerseu, Director, Chicago Lighting Institute; Professor John O. Kraehenbuehl, Professor of Electrical Engineering and Illumination, University of Illinois; B. J. Martin, Publisher, *Electrified Industry;* J. Francis McCabe, Superintendent of Buildings, Chicago Art Institute.

Gold Seal Awards

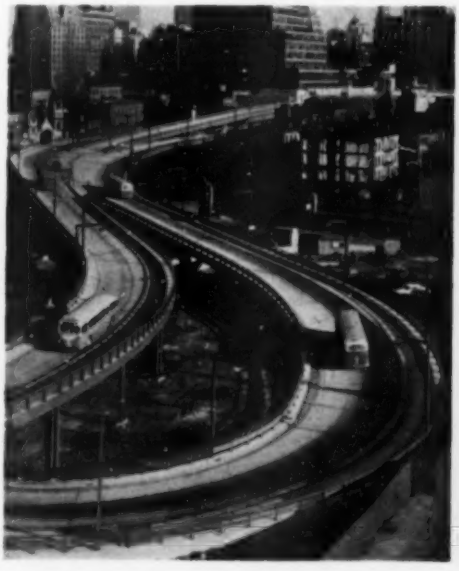
The Winners!



No. 230—Utility Representatives Group—Vincent D. Mitchell, Rochester Gas & Electric Corp.

This charming bank lobby employs some of the best in lighting techniques — and light-colored interesting materials. Two types of luminous "systems" have been used. A cove, which one might characterize as being a rich or dignified type of lighting has been employed in the public space where footcandles are not quite so necessary. A louverall ceiling is used in the cashiers' and bookkeeping areas. Cove lighting uses four rows of 20 mm 3500° white cold cathode lamps operating at 60 ma, 12,000 volts, in each cove. The louver ceiling lighting uses two-lamp, 48", 72" and 96", 420 ma slimline strips (special) on 2' 1" centers, suspended from the old ceiling. Lamp centers to top of the 3" deep louver is 1' 4"; ceiling painted flat white. Louver sections are 2' x 4' x 3" deep aluminum painted white. Illumination levels after 8 months' operation are 90 ft-c in the bookkeeping department; 75 ft-c around the perimeter of the cove in cashiers' area and offices, and 35 ft-c under the cove (customer area).

No. 481 — Owners and Users — W. Henschel, Port of New York Authority, New York.



The problem of lighting the overhead viaduct of the New York City Port Authority Bus Terminal was two-fold. (1) To provide adequate and efficient roadway lighting for heavy bus and passenger car traffic. (2) To light the ramps in a distinctive manner, definitely identifying them with the Bus Terminal and facilitating motorists' access to the Parking Roof. Sodium vapor lamps have been employed among a myriad of white incandescent light sources. The attention-arresting effect of the ribbon of light can only be appreciated from a night-time photograph, in color, not possible here. Mounting height of the installation is 25 feet 5 inches from roadway to light center of lamp, a suspension mounting being used between the bracket and the luminaire to absorb traffic vibration. Illumination level is 1.5 footcandles average.

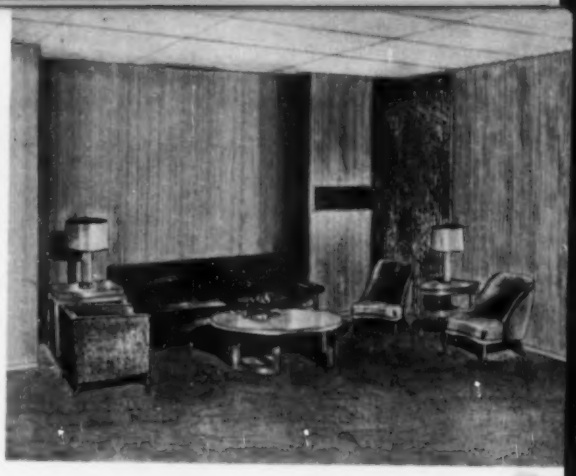
No. 233—Utility Representatives Group—Roger W. Renkel, Union Electric Co. of Missouri, with E. W. Stohlmann, Jr.

Greatly appreciated by the night crews, who must work without benefit of natural light from the skylights, is the high level of illumination in this railroad freight station. The 696 300-watt clear, incandescent reflector lamps in industrial type domes with glass covers provide 14 footcandles at working level from the highest bay, 30 feet, and 18 footcandles from the low bays at the sides, 22 feet above the platform. In addition there are 172 extension cord drops suspended overhead on spring rewind reels at intervals of 44 feet along each platform. These units, containing 100-watt clear incandescent lamps, are so placed that they can be taken inside the freight cars being loaded or unloaded at the platform. Distribution of power was a major problem in this installation, because of the size of the terminal — five acres. For this service a 3-phase, 4-wire, 208-volt system was installed with twelve feeder circuits to serve the lighting and three for power.

No. 290—Owners and Users Group—George E. Pieper, Metals & Controls Corp., with Donald W. Somes and Ernest J. Precourt.

In this high bay area, a level of only 30 footcandles is necessary, the equipment being large and the work not a critical seeing task. The lighting units, each with two 85-watt standard cool white lamps, are mounted at a height of 21′ to avoid a traveling crane. The louvered luminaires, which give 40% upward component of light, are arranged in three continuous rows, with the middle row somewhat off-center, because of the center strut of the girders. The wiring was done with a 4-lamp, 236-volt ballast in one 5-foot section and no ballast in the next. This was found more economical than having 2-lamp 115-volt ballasts in each section. Ceiling and piping above the luminaires are painted white. *Photograph by permission of Metals and Controls Corporation.*

No. 420 — Electrical Contractors Group — Harold H. Lundberg, Wadeford Electric Co.



The problem in lighting the consulting room in this psychiatric hospital was to produce without discomfort to room occupants sufficient vertical and horizontal illumination to record on kodachrome 16mm film the facial and physical expressions of normal persons and persons having personality maladjustments, obtaining a relatively complete record of the behavior for analysis of the treatment process. Opinion indicates that approximately 150 footcandles on the vertical is sufficient to give satisfactory results. To achieve this, 300-360 ft-c are necessary on the horizontal. To minimize disturbing patterns on the ceiling and to conceal the lamps, a luminous paneled ceiling was decided upon. For best color results, cool white de luxe lamps were selected. Supplementary incandescent floor and table lamps provide highlights and shadow. With the lamps on 6-inch centers in the comparatively confined space, cross ventilation, thermostatically controlled, has been provided to prevent unwanted temperature rise. All operating equipment is located in a separate room to eliminate ballast hum. Three openings with camouflaged lenses in automatically operated cameras are located in one of the walls. Films are soundtracked to record the voices. Room furnishings are arranged to prevent occupants from moving out of camera range. Brightness readings are: ceiling, 550 ft-L; light green wall areas, 95; figured light green panels concealing cameras, 95. Average vertical footcandle level on the face of a person seated on the settee is 130. To avoid sharp contrast between this highly lighted room and the corridor leading to it, strip lighting has been installed on the walls of the corridor to provide a level of 60 footcandles. *Photographer: Schube-Soucek.*

No. 432 — Distributors' Lighting Specialists — J. E. Donaldson, General Electric Supply Corp.

The lighting in this general office area was designed to obtain maximum intensity with low surface brightness and to avoid, as far as possible obsolescence in style and appearance. Single lamp deep troffers with aluminum reflectors and cross baffles on 6-inch centers are equipped with 96-inch T12 slimline lamps operating at 430 ma. The luminaires are installed in continuous rows on three-foot centers running across the direction of view of the office personnel. Suspended from the same hangers is a metal-pan acoustical ceiling at a height of 10' 6". The average illumination after six months' service was 76 ft-c. Ceilings are egg-shell with white matte finish, walls are green, partitions a light green, floor gray tile and desk tops dark gray.

No. 479—Architect's Group — Charles S. Telchin, Telchin & Campanella.

A combination of incandescent and fluorescent lighting designed to highlight the sparkle of the merchandise, is employed in this winning installation at the Ralph M. Fava store, Jewelers and Silversmiths, Paterson, N.J. A level of 75 footcandles general illumination is obtained from continuous rows of fluorescent luminaires, while 110 footcandles is punched to the merchandise on display, from incandescent reflector units. Reflectance values of the surfaces are 75% ceiling, 60% walls.

No. 287 — Electrical Distributors Group — George E. Pieper, Metals and Controls Corp., with Donald W. Somes and William J. Metters.

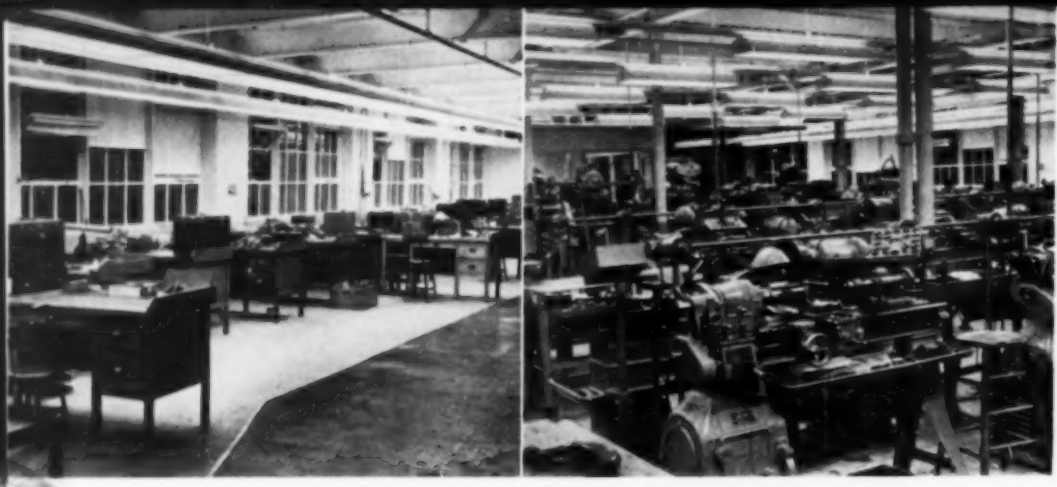
If quality is the next step in industrial lighting, this machine shop is a step in front on all counts. Brightnesses have been considered as important as high illumination levels in the finished rolling mill of this plant, where high-polished metal is rolled. Ceilings are white; machines are light blue; the luminaires employed have a 40% upward component. Continuous rows of Alzak aluminum units, using standard cool white 40-watt fluorescent lamps, provide 70 footcandles after 18 months' operation, 16 hours a day. *Photograph by permission of Metals & Controls Corp.*

No. 575—Owners and Users Group — Joseph R. Behan, Central National Bank of Cleveland.

The plenum of this acrylic plastic luminous ceiling was purposely painted a dark gray to "soften" the lighting results, and to provide a slight unevenness in the lighting across the entire area. This was planned deliberately to eliminate too flat an appearance to the ceiling, and too harsh a lighting effect. Plastic pieces are 48" square, carried on aluminum bars and may be removed easily for maintenance. Single tube 96" and 72" luminaires are mounted in rows on 36" centers, approximately 30" above the plastic, using 430 ma slimline lamps. Lighting level is 40 footcandles maintained. *Photograph: Rebman Studio.*

No. 177 — A Girls' Shop
Electrical Contractors Group — H. G. Hrivnatz, Houston Lighting and Power Company.

Fluorescent skylight luminaires and recessed incandescents are combined in this "Girls' Shop" with the purpose of simulating natural daylight. Average illumination over this 170 sq. ft. area is 33 footcandles. To highlight the manikins and display showcases and wall cases, adjustable spots give a level of 110 footcandles on manikins and fluorescent lamps in cases provide 62-74 footcandles. Walls are powder blue and tearose pink, carpeting is rose-beige, the ceiling is described as "twilight sun." (Photograph does not do justice to this installation, having been made from a four-color transparency.)



No. 284 — Electrical Contractors Group — George E. Pieper, Metals & Controls Corp., with Donald W. Somes and Ernest J. Precourt.

Over the toolmakers' benches (above left), where a level of 75 footcandles maintained is needed, continuous rows of louvered luminaires, each equipped with two 40-watt standard cool white lamps, are hung on adjustable hanger channel at a height of 8′ 6″. Over the machines (above right), where supplementary lighting would be needed no matter how high the general illumination, the same type units are installed 7′ apart for a modest 45-footcandle level without the local lighting. Machine surfaces have light finishes; ceiling and pipes have been painted white. *Photograph by permission of Metals and Controls Corp.*

No. 267 — Distributors' Lighting Specialists Group — W. E. Watson, Graybar Electric Co.

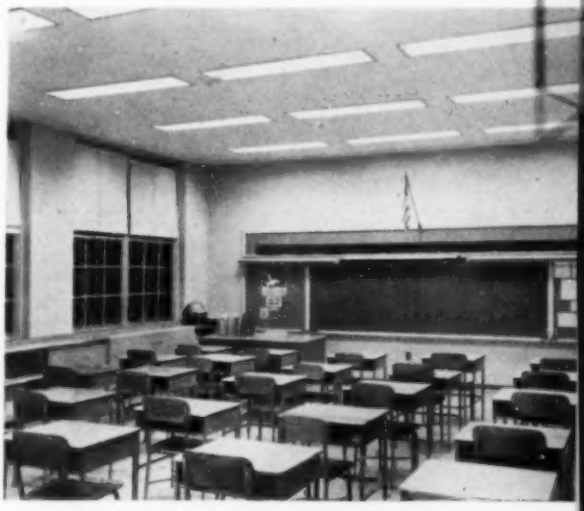
General illumination in the sales area of this furniture store is provided by 24″ square reflector units with metal eggcrate louvers using silvered bowl lamps — 24 500-watt, 104 300-watt, 60 200-watt — and 50 recessed 150-watt projector floodlights. In the ceiling cove are single-lamp T8 slimline strips with warm white lamps; in the wall cove is a double row of T12 slimlines with cool white along two walls for white goods and warm white along west wall for furniture. The entrance vestibule has 20 recessed 150-watt projector floods; in window areas a total of 91 recessed 150-watt reflector floods. An average level of 80 footcandles is provided in the sales and display area. Walls are green (33% RF); one wall is brown (20% RF); floor is light gray asphalt tile with brightness of 32 footlamberts.

No. 407 — Utility Representatives Group — Harry L. Nicol, General Electric Supply Corp., with Larry R. Nall, Detroit Edison Co.

Remodelling of Tilson's Women's Accessory Shop in Detroit included the installation of latest lighting techniques — a luminous ceiling with acoustical baffles, plus incandescent lighting for accent and color value. The ceiling is of translucent corrugated acrylic plastic sheets, with acoustical baffles suspended below the luminous ceiling on 36-inch centers. Illumination is from F96T12/CW lamps placed 18 inches above the ceiling and spaced in continuous rows on 18-inch centers. Accent lighting is supplied by adjustable louvered downlights using 150-watt R40 reflector lamp, these units mounted flush with the plastic ceiling panels. General lighting from the luminous ceiling is 125 footcandles; downlights produce accent lighting of 200 footcandles. This is an open-front store and every piece of merchandise can be viewed from the street under these high levels.

No. 364 — Utility Representatives Group — Richard A. Masterson, Public Service Electric & Gas Co., with E. T. Brown, Architect.

The aim in the lighting of this classroom was to provide visual comfort with a minimum of maintenance. An average horizontal footcandle level of 53 is supplied by 18 recessed aluminum troffers with longitudinal baffles that give 25-degree cross-light shielding. These units are each equipped with two 40-watt T-17 low brightness lamps. Efficiency is approximately 58 per cent. Colors and reflection factors of surfaces are: ceiling, white acoustical blocks, 65 per cent; walls, light gray, 20 per cent; chalkboard, green, 20 per cent; tackboard, light green, 30 per cent; floor, gray linoleum, 25 per cent; desk tops, light maple, 30 per cent. Brightness ratios are all better than 3:1 except that of ceiling to luminaire which is 1:11.



No. 334 — Distributors' Lighting Specialists Group — Thomas J. Pifer, Westinghouse Electric Supply Corp.

An initial calculated level of 2.5 ft-c average is provided on Stone Street, Falls City, Neb., by the 54 aluminum reflector luminaires mounted at a height of 31′ 6″ on round monotube steel poles. These poles are equipped also with duplex festoon outlets for the operation of Christmas lighting. The entire system is fed from a 3-wire underground multiple 120/240 volt type distribution. *Photographer: Morsman Studios.*

No. 187 — Utility Representatives Group — James F. Finn, Detroit Edison Co.

Planned lighting, as a modern concept, includes cleaning and painting. In this industrial plant, the reflectance factors of ceiling, walls, machines and floor were tripled after oil deposits and stains were removed and surfaces were painted. Machinery was painted a medium green, walls light gray and ceiling flat white. Two-lamp direct-indirect louvered luminaires equipped with 75-watt T12 standard cool white lamps operating at 430 ma, provide 50 footcandles general illumination and 75 footcandles on the working edge of machines. The lamps are shielded 35° crosswise and 25° lengthwise. Photo was taken after six months of operation. The customer reports that the renovation has decreased employee fatigue and improved morale.

No. 227 — Architects Group — John D. Perry, Delbert K. Perry, New Britain, Conn.

Quality lighting of oil paintings at a reasonable cost, was the aim of this installation. Thirty commercial luminaires were used, each using four 40-watt fluorescent lamps, two tubes on each side of a V chassis. These were modified with a center vertical baffle to conceal all light sources when viewing the paintings from normal distance. The units run continuously in a rectangle with four special matching 45° mitred fixtures for the corners, these using two 20-watt fluorescent lamps on the inside row and two 30-watt lamps on the outside row. The wiring is so circuited that maximum flexibility is obtained by (1) the inside perimeter of lamps may be used when displays are held in the center area, (2) the outside perimeter of lamps around the gallery may be on for viewing pictures only and (3) the special corner fixtures may be used separately by the night watchman. Average illumination on the paintings, vertical plane, is 32 footcandles. *Photograph by E. Irving Blomstrann.*

No. 489 — Architects and Engineers Group — Herbert A. Delius, Delius & Thomas, Engineers.

The remarkable brightness ratio of 1.625:1 maximum is achieved in the Oakland main office of the Bank of America, Oakland, Calif., with an average illumination level of 50 footcandles. The louverall ceiling is composed of hinged removable panels supported in 48" x 48" fabricated steel frames. The louver cells are 2" x 2" square and 2" deep, giving a 45° cut-off. The alumnum louvers and steel frames are finished with an off-white baked enamel finish. Above the ceiling, strip lighting contains 2-lamp, 40-watt and 75-watt T12 instant-start standard cool white lamps, with one dual lamp ballast serving each pair of lamps.

No. 530 — Architects and Consulting Engineers — L. Ralph Bush, Atlanta, Georgia.

Lighting engineering for comfort, esthetics and high levels, won a Gold Seal Award for this job in the Atlanta Public Library. L. Ralph Bush, consulting engineer, did the lighting; Tooms and Creighton, Atlanta architects are responsible for the architectural design. Fluorescent lighting has been combined with incandescent within one unit, for an average level of 56 footcandles, with brightness contrasts carefully controlled.

No. 244d — Electrical Contractors Group — Lynn R. Kestenholtz, Lansing Electric Motors.

Translucent acrylic, in sections 47½" square, with aluminum division bars, forms the luminous ceiling in this pleasant private office. Channel strip sections in 16' lengths with symmetric reflectors are equipped with two 96-inch instant-start slimline lamps operating at 200 ma. Maintained level is 48 footcandles.

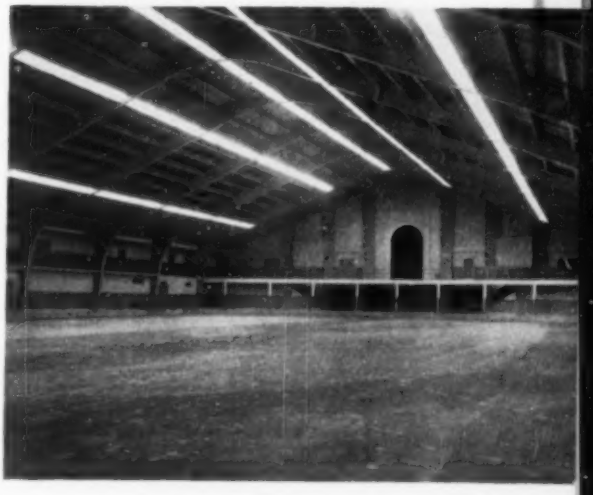
No. 294 — Utility Representatives Group — Duncan Preston, Detroit Edison Co., with Floyd Sell.

This Gold Seal winning job was first reported in the pages of this publication in August 1951 (p. 389). It represents a system developed after eight months' research, to provide artificial light of a color sufficiently close to north sky light to judge properly live mink and fox fur. A light-reflecting hood employs a tempered masonite panel lining painted with a special blue lacquer, and 1500-watt photoblue lamps directed upwards to the reflecting surface. In each section of the device, four industrial reflectors mounted on a standard length of strip house the lamps, burned base-down. Illumination on the judging tables averages 130 footcandles.

No. 542 — Owners and Users Group — Carter Lewis, Union Electric Co. of Missouri, with Joseph Bettendorf.

The owner of this market and his department heads made considerable research through discussion and observation of various types of lighting installations before deciding upon a fully incandescent installation. Benefits they claim after a year of use are the avoidance of discoloration of products, especially meats, as well as color contrast of all products, and a minimizing of glare with the light distribution more nearly at the purchasing level. The incandescent lamps are mounted in mirrored glass recessed luminaires. In the lower ceiling height area, around the wall area of the market the units are equipped with concentric rings. In the center part of the market the concentric rings were omitted. The whole store can be divided into four areas with the following illumination levels: the front section (lunch counter, check-out stations and miscellaneous), 31 ft-c; center section (vegetables, grocery, frozen foods), 43 ft-c; meat department, 38 ft-c; and bakery goods, 31 ft-c. Average over the market is 40 ft-c with wattage of 4.2 watts per sq. ft.

No. 256 — Field House Lighting — Harry F. Gill — Graybar Electric Co. — Distributors' Lighting Specialists.



This field house is divided by a mesh screen into two areas — a basketball court and a general play area (shown in photo), the total length being 313'4" with a width of 134'4" and height of 44'. Porcelain enameled open end reflectors are installed in rows between girders for the full length of the house. Each section between girders is composed of three pairs of units of two 96-inch T12 lamps per luminaire. Spring lamp holders are mounted on 5-foot centers. The units are mounted on rigid steel supports on steel blue purlins and placed tangent to the arc of the roof truss so that the axes of the two bands on both sides of the center are directed slightly toward the center. The units are protected by special 2" x 2" mesh aluminum guards mounted on the bottom. *Photograph by David Royter.*

Combination Lighting For Viewing Paintings

Special Exhibition Gallery Lighting, Boston Museum of Fine Arts

By MAURICE FEATHER
WILLARD W. THOMPSON

ARTIFICIAL lighting for the display of art treasures has generally been looked upon with skepticism by museum curators because it was believed that natural illumination best captured the intrinsic qualities of works of art. Natural light, however, is not constant and cannot be regulated to any great degree by man. Over the years it has been necessary to supplement the daylight with artificial illumination. Despite the many and various applications of artificial lighting, until very recently it was not considered that such illumination produced such satisfactory results that form and color appeared in their natural state.

Studies of galleries in this country and abroad indicated that a new approach was needed. Museums in the past had been largely supported by private funds, but the future outlook indicated that most museums nowadays would have to be supported by public funds. This circumstance would undoubtedly create a demand for the museums to be open in the evenings so that the public could visit them after normal working hours. In that event, artificial lighting would have to play a more important part in the showing of the collection to the public.

The problem of lighting museum galleries was divided into two parts. First, if natural lighting were used, it would have to be the predominating factor, and artificial illumination would be merely a supplement to it. Secondly, if artificial lighting were to predominate, then natural lighting would not be necessary. However, in the application of the artificial lighting it would be necessary to provide artificial illumination closely assimilated to natural lighting in black body color temperature. The artificial illumination would also have to be variable so that it could be adjusted to conform to the different colors and thus display to the best advantage the artist's original conception of the picture.

Authors: Maurice Feather is a partner in the firm of Leland and Larsen, Architects, of Boston, Massachusetts. Willard W. Thompson is principal in the firm of Thompson Engineering Company, Illuminating Engineers, of Boston, Massachusetts.

In 1950 at the Museum of Fine Arts in Boston, experimental lighting was installed in the Recent Accessions Room, combining incandescent and fluorescent lighting. This combination proved very successful and indicated that this was the right approach to the problem of lighting museum galleries. The lighting for the new special galleries at the museum was similarly designed to provide a combination of incandescent and fluorescent lighting, with the exception that the center skylight effect was changed from coffers to luminous diffusing panels. The diffusing panels in the center of the room produce the effect of a natural skylight, while the fluorescent-incandescent perimeter lighting provides the additional illumination on the walls. An outstanding feature of this installation is the realistic reproduction of color and depth of perspective that is obtained by the use of a careful mixture of incandescent and fluorescent lighting.

The perimeter fluorescent reflector units provide a constant level of lighting on the walls and the correct color temperature for the individual pictures is obtained by varying the incandescent lighting. This is done by the use of a dimmer for each side of the room, and as each lamp is also switched separately, a very fine adjustment of the level of illumination can be obtained for the different areas. This variation is shown in Fig. 2, where it will be seen that some incandescent lamps are not turned on. This is because the color make-up of the particular picture under the light does not require any additional incandescent illumination to provide the correct color temperature. Even if in certain cases some of the incandescent lights may not be turned on, there is still no apparent lack of uniformity in the illumination and no suggestion of an uneven effect. This is because there is a certain amount of spill of incandescent lighting available which is sufficient to give the proper color temperature and depth to the picture.

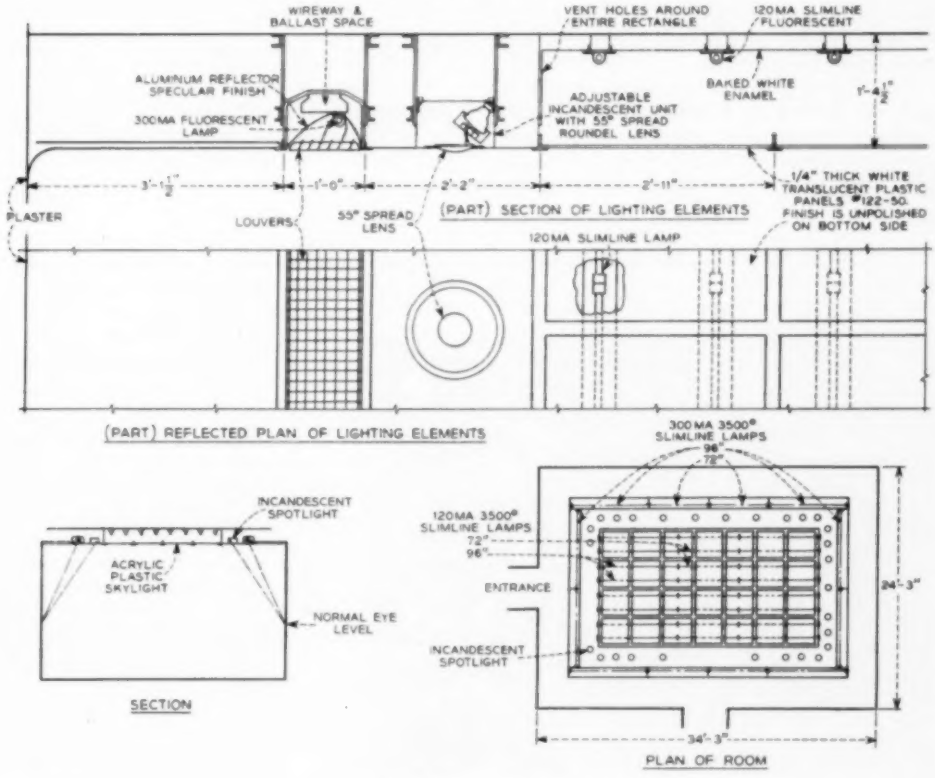
The perimeter lighting units are of the recessed troffer type, with provision for horizontal and vertical shielding by means of louvers. The size of the

Figure 1. Fine Arts Museum, Cast Court Galleries, with central fluorescent luminous panels turned on.

Photographs General Electric Co.

Figure 2. Same galleries with both central fluorescent panels with perimeter lighting and variable incandescents.

Figure 3. Elevation and plan views of the gallery.



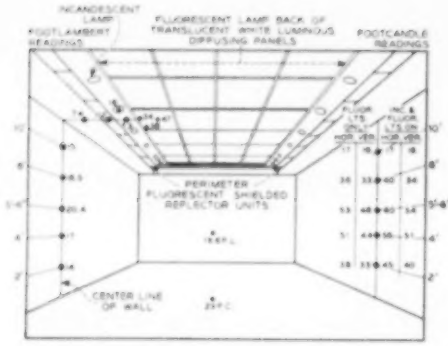

INCANDESCENT LAMP FOOTLAMBERT READINGS
FLUORESCENT LAMP BACK OF TRANSLUCENT WHITE LUMINOUS DIFFUSING PANELS
FOOTCANDLE READINGS
PERIMETER FLUORESCENT SHIELDED REFLECTOR UNITS
CENTER LINE OF WALL

Figure 4. Illumination and brightness readings.

specular aluminum parabolic reflectors is such that it amplifies the bare lamp candlepower of the 300-ma lamps, while the reflectors are designed to produce the highest illumination level in the approximate area five feet six inches above the floor, which is the eye line or picture level.

The incandescent units consist of an adjustable fixture with asymmetric spread roundel lens, so arranged that the entire area of the wall is illuminated from corner to corner.

The diffusing plastic panels in the center of the room are divided into rectangles and supported from a tee-bar construction. Behind these panels fluorescent lamps are spaced so that two lamps cover each panel. These lamps are of the low brightness, 120 ma, T8, 3500° type. The entire closure above the center panels is finished baked white enamel and provides a good reflecting surface. Vent holes are provided through this reflecting surface on the top and sides. Details of these fixtures are shown in Fig. 3.

Footcandle and footlambert readings are indicated in Fig. 4. From this diagram it will be seen that the illumination in the center of the room produces a reading of 20 to 25 footcandles, while the addition of the fluorescent and incandescent lighting on the side walls, with normal voltage for the incandescent lights, increases the footcandle readings from 53 footcandles for fluorescent lighting only to 60 footcandles for the combination lighting. Normally, however, the incandescent voltage would be reduced to approximately 80 to 100 volts by the dimmers, depending on the particular requirements of the amount of incandescent lighting needed by the pictures being displayed.

The brightness ratio of 20.4 footlamberts at the five feet 6 inches level and 7.4 footlamberts on the ceiling indicated on Fig. 4, is approximately three to one, the brightest area being the louvered unit of the fluorescent reflector, which is approximately a five to one ratio with the brightness on the wall at the five feet six inches level.

From the illustrations it will be seen that the general effect of the center skylight and the combination of fluorescent-incandescent lighting on the walls produces a balanced illumination for the room and for the pictures being displayed.

WAITING ROOM in the Fort Street Union Depot in Detroit is 64 x 90 x 16 feet in size. Two-lamp recessed troffers with control lenses are installed in 10 broken rows of one 12-foot and two 16-foot sections per row, 4 feet between each two sections. The rows are on 9-foot centers and illumination ranges from 30 to 35 ft-c throughout the area. Walls are buff marble and terra cotta plaster; seats are oak. *Photo courtesy General Electric Co., Cleveland, O.*

The lobby at 383-385 Madison Avenue in New York City has a sloping ceiling illuminated with changing patterns and designs of colored light.

Color Changing Hexcrate Ceiling For An Office Building Lobby

By ROLLO GILLESPIE WILLIAMS

IN THE LOBBY of the newly redesigned office building of Webb and Knapp Co., New York City, a completely new element has been added —namely color change lighting as an integral part of the architectural design.

In anticipation of a boom in the creation of new office space in central Manhattan, William Zeckendorf, President of Webb and Knapp embarked on changes of the building known as 383-385 Madison Avenue, New York, and has executed what is considered the most ambitious renovation and conversion scheme ever carried out for a New York office building. One of the most important parts of this program concerned the provision of a new glass fronted entrance lobby, over 37 feet high, with a sloped hexcrate ceiling extending downward and backward from the top of the large plate glass windows to the level of the elevator corridors.

Author: Color Lighting Corp., North Bergen, N. J. Mr. Williams is the inventor of the color-change system described, and lighting designer for the installation.

A special hexcrate ceiling was created for this space, in itself a new architectural form. The hexcrate is composed of six-inch hexagonal cells marshalled in honeycomb strips lying flat over the elevator loading corridors and curving upward for two and three-quarter stories over the lobby proper to meet the great street window. This hexcrate ceiling, as well as the lighting system behind it, is hung from an intricate network of horizontal and vertical channels, the latter following the curve of the hexcrate all the way down.

Changing colored light, electrically controlled by the daylight, plays down through the hexcrate ceiling, making it an object of great beauty. The lighting system can produce fixed patterns of light, changing and merging patterns, designs of light in which some parts change and other parts are static, or special effects for certain occasions. The color-change lighting system will produce a basic range of over 500 different tones of color and the merging and flowing of the colors can be pre-set in

Figure 2. Workmen putting up the curved hexcrate ceiling. Some of the lighting equipment is in position and can be seen behind the ceiling.

desired patterns and arranged for various time cycles.

Batteries of lighting strips electrically divided into 48 unit areas, illuminate the hexcrate ceiling from behind. Each unit area is approximately 25 square feet in size, but these unit areas have no counterpart in the hexcrate ceiling itself which is seen as one complete area. The lighting system is designed so that selections of the 500 different basic colors can be produced in each of the 48 unit areas independently of all the others. The lighting equipment for each of the 48 electrical unit areas is made up of 40 150-watt Reflector Floodlamps wired on four color circuits, mounted on four lighting strips each carrying ten lamps. Thus, there are a total of 192 ten-lamp lighting strips mounted behind the hexcrate ceiling. The lamps for each unit area are grouped on four circuits to provide the four primary colors of light which are used in the color-change system, by provision of carefully chosen glass color filters held in caps fitted on to the lamp bulbs. The four colors in question are red, green, blue and white.

In order to get the delicate shadings of color which are seen in the hexcrate ceiling from below, it was necessary to locate the lighting strips accurately behind the hexcrate ceiling with a maximum tolerance of one-eighth inch. The four strips in each electrical unit area are all differently angled and the maximum permissible tolerance in the tilt is 1°.

There are a total of 1920 reflector lamps in this color lighting installation giving a total connected load of 288,000 watts. The color-change control equipment is designed so that at no time does it require an operating load of more than 220,000 watts; the average working load is more in the neighborhood of 170,000 watts.

Master Controllers

The installation is operated by two color-change master controllers which, by means of a single control knob only, enable accurate selection of desired colors from the range of 500 hues. Pre-setting facilities on each controller enable 20 selected colors to be quickly set up in a desired order and automatically reproduced at any desired time cycle, with the interval between changes varying between extremes of 6 and 120 seconds according to choice. Figure 3 shows a color-change controller of the type in question. The chromatic selector scale is seen at the top and the selector operating knob in the middle, while the pre-set selector mechanism is located on the left hand side. The handwheel at the bottom is for experimental uses when the controller is not set for automatic operation. To provide automatic operation, one simply has to operate a switch on the right of the front panel.

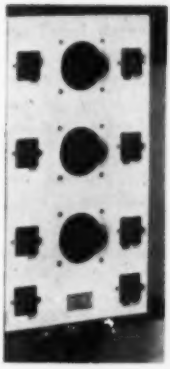
The entire lighting system can be operated from either the color-change controller or when the lighting pattern so requires, both controllers may be used simultaneously. To enable each controller to handle a load of 288,000 watts, electronic reactor equipment is employed. The controllers themselves activate potentiometers and these in turn are connected to electronic control equipment which determines the output of a number of reactor dimmers. There are twelve 9-kw and twelve 15-kw reactor dimmer units. These, together with the electronic rectifying tubes and control units, boosters and other necessary parts, are mounted in two iron frameworks, each approximately 88 inches high, 52 inches deep and 32 inches wide located away from the color-change controllers, which of course determine their action.

The output circuits from the reactor equipment are taken to a color-change contrast panel approximately 17 feet 3 inches wide, by 73 inches high, by 19 inches deep. From here, the 192 outgoing circuits are taken to the lighting equipment.

This contrast board is arranged so that any circuits can be connected to any particular reactance dimmer. The main feature of this control

Figure 3. Master control mechanism of the type employed. Two of these controllers master-control the whole lighting installation.

This panel shows three contrast switches. In this installation 48 of these switches are used.



board, however, is the device's contrast switches which enable any of the 48 electrical unit areas of the hexcrate ceiling to be illuminated in a different color to the one selected by the color-change master controllers. There are 48 color contrast switches, one for each unit area. Operation of a contrast switch causes the light of the unit area associated with it to be changed in color relationship to the color provided at any moment by the color-change master controllers. Thus, if the whole ceiling is illuminated in lavender light and it is desired to make unit area No. 21 look different at that moment, then operation of contrast switch No. 21 will immediately cause the unit area in question to take on one of a number of different, but harmonizing colors to lavender, according to the movement of the contrast switch. Thus tints of pale green, pale blue, light orange etc. may be provided on the unit area No. 21 by operation of the associated contrast switch instead of the lavender hue reproduced by the selection made on the master color-change controller.

In this way, patterns may be built up on the ceiling by simultaneously illuminating different unit areas in different colors of light. In other words, there are 48 blocks of color, any or all of which can be the same or different at any time, and designs can be built up with these different colored areas. Inasmuch as each unit area can be any one of the 500 colors available from the device's range, the number of possible lighting patterns is tremendous and exceeds the number represented by the digit 7 followed by 43 zeros. Fig. 4 shows three contrast switches.

Since it is impossible to conceive of or view the final effects of the whole ceiling from the control room (which is located at the back of the ceiling), a viewing panel, which is a complete replica of the ceiling in miniature, is provided in the control room to enable the operator to view the effects and to set up quickly the desired color patterns. The viewing panel measures approximately 68 inches in width, is 48 inches high and 15 inches deep and contains 48 separate compartments each fitted with four-color lighting which is connected in parallel with the actual lighting circuits behind the ceiling. In this manner a complete reproduction of the lighting effects seen from below on the hexcrate ceiling may be viewed in miniature by the operator.

Daylight Conditions

A considerable amount of daylight falls upon the sloped hexcrate ceiling and it is desirable to control the degree of color saturation in the selected colors of light, according to daylight conditions. Red-sensitive and blue-sensitive phototubes are concealed in the lobby and in conjunction with electronic amplifier and selector equipment, varying electrical signals are sent to the color-change controllers according to daylight conditions. The master color-change controllers are provided with special features which respond to the signals received from the phototubes and regulate the degree of white light in the color mixtures. As daylight increases in intensity, the controls automatically compensate by de-saturating the color of the lighting. Conversely, as daylight decreases, the colors are deepened in hue.

At the present time, the color-change lighting is in use from 8:15 a.m. to 10:00 p.m., seven days a week, a total of over 96 operating hours per week. On the basis of two color changes a minute, this means over 11,500 color changes a week or nearly 600,000 changes per annum. Inasmuch as there have been periods in which the rate of change has

been much faster, the annual number of lighting changes based upon the average of the last few months will mean over 1,000,000 color lighting changes per annum.

The two flat portions of the hexcrate ceiling are lighted with a total of 102 slimline lamps. All but one of these lamps is a 64-inch slimline tube fitted with 200 ma two-lamp hi-power factor ballast. These tubes are mounted above the hexcrate ceiling and provide even white lighting which acts as a pleasant background to the variable color lighting on the sloping front ceiling.

The "Lobby of Light" at 383 Madison Avenue has fully justified its cost because the building is already internationally famous and has been described by a leading periodical as "the most talked-about, stared-at building in New York City." People from all parts of the U.S.A. together with visitors from many other countries continue to visit this lobby in order to view the lighting, and the value of office space in the building is enhanced by this interest.

The system can also be used as a static design — for instance, a red cross in line with a campaign.

Acknowledgments

I should like to take this opportunity of expressing gratitude to Mr. William Zeckendorff for the encouragement he has given me in my researches, and for giving me a free hand to install this lighting system on a large scale as an integrated part of the architectural design of the new Webb and Knapp lobby. Acknowledgment is also made to Paxton, Krueger and Associates, Inc., in association with Norman Bel Geddes for their breadth of conception as designers of the lobby, and to Rudolf C. P. Boehler and Albert W. Lewis, both of Webb and Knapp, Inc., as architects.

Are Comfort Rating Systems Ready?

Resumé of an address by Dr. Ward Harrison at the Great Lakes Regional Conference, May 5, 1952

For any room utilizing a single light source, whether it be a single large globe or a uniformly luminous or indirectly lighted ceiling, the answer should be unqualifiedly "yes." The Luckiesh-Guth fundamental data permit of calculating with reasonable accuracy the percentage of people who will regard such rooms as comfortable for a fixed size and brightness of light source.

The difficulty wih the Luckiesh-Guth data arises when one attempts to compute the sum total effect on comfort of a number of sources located in different parts of the field of view. Mr. Guth has suggested one method of evaluation but this method is open to some objections. Mr. H. L. Logan recently proposed a unique way of summating the effect of multiple light sources, but in his case the results do not check too well with the Luckiesh-Guth observed data. Some modification of the Logan method may prove to be a satisfactory way of applying the Luckiesh-Guth research.

The Harrison-Meaker glare factor system when used to evaluate single light sources will, in general, give the same results as the Luckiesh-Guth method; in fact, it makes use of their data. In most cases, also, it checks reasonably well with their laboratory results on small multiple sources, and for larger sources, the agreement is perhaps still better. The glare factor system which was originally based largely on experience is also closely in accord with expert appraisal of actual lighting installations. It is being adopted in Australia and in Switzerland as the basis of legislation against glare.

The practical use of comfort rating systems is to forecast the satisfactoriness of a lighting layout *before* the installation is made. Either of the two rating systems discussed above may lack precision; nevertheless they afford a far better advance appraisal of direct glare than can be obtained in any other way. In view of this fact, it would not seem an overstatement to say that comfort rating systems *are* ready.

Lighting a Court House

Installations at Montgomery County Court House, Norristown, Penna.

Installation A — Court Room

LIGHTING OBJECTIVE: To provide 30 to 50 footcandles for the judge, court clerk, recorders and attorneys and a lower level for the auditorium.

General Information: The court room measures 33 x 40 x 22 feet. Ceiling is white acoustic tile with 72 to 75 per cent reflectance. Walls and woodwork are colonial ivory (62% RF); floor is white marbelized tile (28% RF); desks, tables and spectators' benches are blond oak (35% RF); and upholstery and door trim are Dutch blue (30% RF).

Installation: Fifteen footcandles general illumination is provided throughout the room by four indirect Silvray No. 208-10 luminaires each containing one 1000-watt PS-52 inside-frosted silvered bowl lamp. These units are suspended 4½ feet below the ceiling.

An additional 15 to 35 footcandles is supplied to the court working area by nine recessed units (Pittsburgh E-500-8 with hinged concentric louver-plaster ring 2-B) each containing a 500-watt PS-40 inside-frosted lamp.

Brightnesses are indicated below:

ceiling	30 ft-L	benches	11 ft-L
walls	15 ft-L	chair upholstery	15 ft-L
woodwork	15 ft-L	door trim	8 ft-L
floor	10 ft-L	desk and table	17 ft-L

(over)

A.I.A. File No. 31-J

Installation B — Lobby

LIGHTING OBJECTIVE: To provide attractive general lighting in a public building stair lobby.

General Information: The court house lobby, between two court rooms, measures 55 x 36 feet. Ceiling coves are 17 to 25½ feet high. The ceiling is white (85% RF); walls are Colonial ivory (62% RF); and floor is white marble (70% RF when clean).

Installation: Ten footcandles illumination is provided by 75-watt R-30 reflector spotlamps in Pittsburgh Permaflectors with Knockout #KO-1 wiring channel and KO-8 sockets spaced on 12-inch centers in coves along the two long sides of the ceiling. The lamps are mounted 17 feet above the floor (center ceiling height is 25½ feet) and are aimed two-thirds the distance across the ceiling. The decorative torcheres, custom built by the Gill Glass and Fixture Company of Philadelphia, each contain a 150-watt inside-frosted lamp.

Lobby brightnesses are as follows:

ceiling	40 ft-L
walls	4 ft-L
floor (when clean)	5 ft-L

For these installations—Architect: E. Lane Crawford; lighting engineer: George William Wagner, Philadelphia Electric Co.; electrical contractor: A. Walter.

Lighting data submitted by George T. Anderson, Jr., of the Philadelphia Electric Company as an illustration of good lighting practice and to aid in the design of similar installations.

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Skillfully engineered incandescent lighting for a large high-ceiling banking area is demonstrated in the new Bank of Nova Scotia Building, Toronto, Canada. The Main Banking Room, shown in the photograph, is 200 feet long and 85 feet wide, with a ceiling height of 35 feet. The coffer technique described below appears to the casual observer as a high expanse of bold louvered ceiling.

Coffer Technique With Incandescents

THE LIGHTING design for this room is a series of coffers, 54 inches square and 24 inches deep, with the sides sloping up to a 16-inch square at the top. Lighting equipment is mounted at the top of the coffer and consists of a cast flange with hinged door, stippled heat-proof cover glass and a silvered mirror reflector with 300-watt incandescent lamp. Relamping is done from above, and the hinged door is so designed that it may be cleaned from above. An interesting detail of the luminaire design is that the glass is spaced about a half inch below the flange to allow exhaust air to filter into the attic above through the luminaire itself. The reflector used for this application is one having a large diameter, to eliminate dark corners on the glass.

The coffers are continuous for the length of the room, are made of pre-cast plaster and have an applied gold finish. Their dimensions are such that a 35° shielding in both directions is obtained. Brightness levels of the coffer decrease down its receding sides, for good brightness conditions.

In the area above the counters on each side of the room, a series of 20 larger incandescent lighting units, using 1000-watt lamps, are recessed in the ceiling, to provide direct light on the counters.

In the main elevator lobby, pendent indirect precast plaster troughs using T-6 and T-8 slimline lamps operated at 300 ma, run the width of the room on about 34-inch centers. The ceiling between the troughs is arched up and the troughs are parabolic in section. Placement of the lamps here is such as to produce a graduated brightness from the bottom of the trough to the maximum on the ceiling at the edge of the next trough.

In designing the lighting installation, a model of the Main Banking Chamber was first made to scale. Different from most miniatures of this type, this model was lighted to about the level that was wanted for the actual room. Lumiline lamps were used over the coffered ceiling area, and flashlight pen lamps were used over the counter area. The general effect made it possible for the architects and owners to visualize the lighting installation as it would appear later in the completed building. This unusual model was later exhibited at the Toronto Art Gallery in connection with an architectural display.

Architects were Mathers & Haldenby and Beck & Eadie; consulting engineer for the building was Dr. K. R. Rubka, Toronto. Data and photograph supplied by H. C. Jones, Toronto Section of I.E.S.

←

Our Lady of Good Counsel R. C. Church, New York City. The beautiful murals of this impressive French Gothic Church are flooded with light from R-40 and PAR lamps concealed behind the partitions adjoining the Altar, each controlled individually to suit different services. Shielded PAR lamps mounted on the columns light the main Altar. The design of the ten chandeliers in the Nave and Transept employs 900 watts of downlight in the lower part of the luminaire, 300-watt lamps in the center, and four 150-watt lamps in angle reflectors, for a wide distribution of light. In addition, in the upper unit of the luminaire are four R30 75-watt flood type lamps sending light upward to the ceiling. *Photograph and data are from F. G. Simmons Co., New York, N. Y.*

Modern Methods

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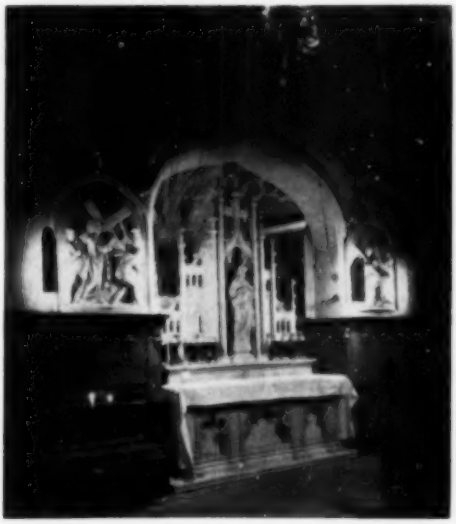
Stations of the Cross, Our Lady of Good Counsel, R. C. Church, New York. Next in importance to the Altar area are the 14 Stations of the Cross. Here, bas-relief figures of the stations are illumination by lumiline 40-watt lamps in shields, one on each side. The recessed shrine is lighted by a double shield on one side of the Station, each of these shields using 60-watt PS lamps. *Photograph and data from F. G. Simmons Co., New York, N. Y.*



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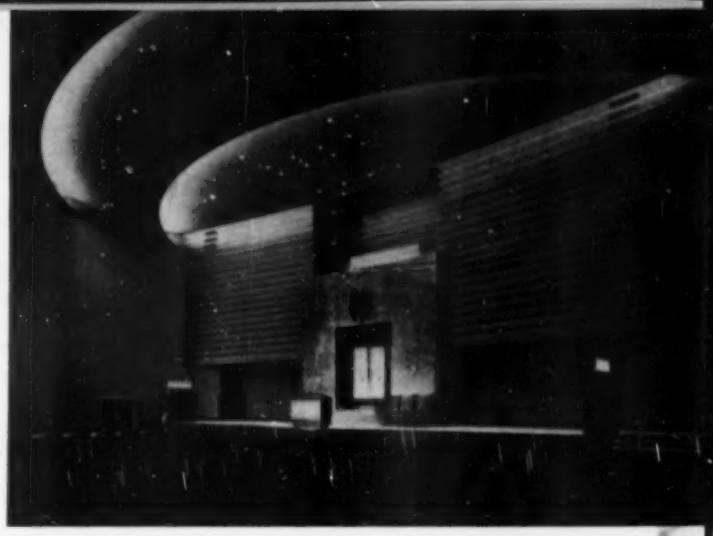
First Church of Christ Scientist, Denver, Colorado. A combination of downlighting and indirect lighting has been used in this large area. The hanging luminaires are of the dome type, giving widespread diffused downlighting; a second circuit projects light upward. The main dome houses eight 750-watt downlights of the "blister" type. Cove lighting is provided by a series of R-40 lamps. *Photograph and data from Rambusch Decorating Co., New York, N. Y.*



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Chicago Sinai Temple. This modern stone structure is more than a house of worship. It is a complete educational institution, containing a large auditorium, many meeting rooms and about 30 well-equipped school classrooms. The auditorium is lighted by a combination of transverse coves containing 100-watt twin fluorescent units mounted end to end and 500-watt downlights. Illumination level is approximately 15 footcandles, with 60 footcandles on the ark. Lighting under the balcony is supplemented by recessed downlights. Illuminating engineer was G. G. Fornoff, Chicago; Architect, Friedman, Alschuler and Sincere.

for Churches

Megiddo Mission Church, Rochester, N. Y. In addition to worship, this church auditorium serves several other parish activities. The elevated area, usually used for the choir and lectern, serves also as a stage for a 30-piece band and for the production of religious plays. Four trap doors cut into the suspended ceiling crosswise to the stage expose four rows of border lights, each row using 27 R40 150-watt lamps with color filters. The sides of the stage have two indirect coves ,each containing 22 100-watt lamps on 6-inch centers. The rear of the stage uses nine 150-watt R40 recessed louvered units. In front of the first border three 150-watt R40 recessed units highlight the lectern during church service. The Nave of the church is illuminated by eight 750-watt indirect luminaires, harmoniously in accord with the architectural design. These units may be dimmed during plays by a switching arrangement which allows each two units to be series operated for first dimming step; from there a smaller dimmer bank controls additional dimming. Each two units are on a separate circuit with #8 conductor to eliminate any voltage drop. *Photographs and data supplied by Thomas J. Whalen, Requa Electric Supply Co., Rochester, N. Y.*

Fundamentals Of Lighting Cost Analysis

By A. C. BARR
C. L. AMICK

ALTHOUGH lighting performance characteristics are the most important factor in the selection of a lighting system, cost is nearly always a consideration. Often, when the lighting performance of different systems is similar, cost becomes the deciding factor. Thus, accuracy and uniformity in cost analysis methods are highly desirable so that analyses by different individuals may be readily and fairly compared.

Of course, cost comparisons exclude considerations of relative lighting quality, which is of equal importance to quantity. Reports showing favorable economy for a lighting system which fails to provide comparable comfort should be accompanied by suitable explanations.

Cost Analysis Objectives

The fundamental cost elements by which different lighting systems must be compared are initial cost and operating cost. While either element may be a dominant factor in the final selection, it is usually desirable to combine these two charges into some type of "total cost" indicator.

The computation of initial, operating and total annual cost for various systems considered for a given interior must be based on certain common assumptions, if the systems are to be fairly compared. Some of the important considerations are:

1. Equal illumination results — since different systems may not produce equal illumination levels in service, all costs should be equated to an equal maintained footcandles basis.
2. Equal rates in amortizing the initial investment and allowing for interest, taxes and insurance should be used.
3. Operating conditions — such as electrical energy rate, burning hours per year and starting frequency of the lamps should be equal for the systems being considered.
4. Cleaning schedule should be appropriate to each type of system.
5. Uniform labor rates among systems should be used for estimating the cost of installation, cleaning and relamping.

Proposed Uniform Method

Table I is a cost analysis showing the effect different light sources might have on lighting costs in an industrial installation where the mounting height of the lighting equipment is 25 feet. The table uses the procedure suggested, and shows the various items of information which must be assembled.

The analysis is divided into four principal sections.

Basic Data

Section A is concerned with the factors which must be established before costs can be determined. Most of these eight items are self-explanatory, but the following comments are pertinent:

Item 3 — For fluorescent lamps, use the manufacturer's published average wattage values rather than values which are often nominal. Actual wattage on most general lighting fluorescent lamps is lower than the rounded values usually quoted.

Item 5 — The coefficient of utilization should be determined for each luminaire considered, and for the actual room size, and room-surface reflectances.

Item 6 — Maintenance Factor should be realistically based on (1) mean lamp output, (2) mean depreciation due to dirt collection on lamps and reflecting elements of luminaire (as estimated from the cleanliness of the air, the design of the luminaire and the assumed cleaning schedule) and (3) loss of illumination caused by gradual darkening of room surfaces.

Item 8 — These are the multiplying factors that equate the systems to a common illumination value. The development and use of these factors provide the quick and easy comparison of relative Initial (Item 14), Operating (Item 22) and Total Annual Cost (Item 23).

Since the primary interest is in *relative* costs, much of the analysis can be made on the convenient and simple "Per Luminaire" basis, *with proper adjustment as mentioned for equal illumination results.* This eliminates the need for considering the illumination level or number of luminaires at this point. Later a simple method is shown for converting the relative values to actual costs applicable to a specific installation.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, August 27-30, 1951, Washington, D. C. Authors: Engineering Department, Lamp Division, General Electric Co., Nela Park, Cleveland, Ohio.

TABLE I.—Cost Analysis. Industrial Lighting Systems — 25-Foot Mounting Height.

	Luminaire Description (Porcelain enamelled steel reflectors)	I — Fluorescent 4 85-watt T17 Std. Cool White 4-lamp ballast 265-volt primary		II — Mercury 1 400-watt E-H1 2-lamp ballast 230-volt primary		III — Filament 1 1000-watt PS-52 120 volts	
A	**Basic Data**						
	1. Rated initial lamp lumens per luminaire	17,600		20,000		21,500	
	2. Lamp life	7,500		(e) 3000 4000		1000	
	3. Average watts per lamp	92		400		1000	
	4. Watts per luminaire (includes ballast watts)	364		430 (f)		1000	
	5. Coefficient of utilization (a)	.62		.59		.59	
	6. Maintenance factor (b)	.65		.65 (g)		.65	
	7. Effective maintained lumens per luminaire (1 × 5 × 6)	7090		7675		8250	
	8. Relative number of luminaires needed for equal maintained footcandles	1.00		.924		.860	
B	**Initial Costs**						
	9. Net luminaire cost (estimated)	$63.00		$25.50		$ 8.60	
	10. Installation (c)	$18.00		$17.00		$11.00	
	11. Net initial lamp cost including tax (estimated)	$ 8.30		$13.60		$ 2.50	
	12. Total initial cost per luminaire	$89.30		$56.10		$22.10 (h)	
	13. Annual owning cost per luminaire 15% of (9 + 10)	$12.15		$ 6.40		$ 2.95	
	14. Relative initial cost for equal maintained footcandles (12 × 8) / (12 × 8) for column I	100%		58%		21% (h)	
C	**Annual Operating Costs**	**2500**	**4000**	**2500**	**4000**	**2500**	**4000**
	15. Burning hours per year						
	16. Annual energy cost (4 × 15 × rate in c per KWH) / 100,000 — 1c per KWH	$ 9.10	$14.60	$10.75	$17.20	$25.00	$40.00
	2c per KWH	$18.20	$29.20	$21.50	$34.40	$50.00	$80.00
	3c per KWH	$27.30	$43.80	$32.25	$51.60	$75.00	$120.00
	17. Number of lamps replaced per year (15 × no. lamps per unit) ÷ Item 2	1.33	2.14	0.83	1.00	2.50	4.00
	18. Lamp cost (17 × net price per lamp including tax)	$ 2.75	$ 4.45	$11.30	$13.60	$ 6.25	$10.00
	19. Labor cost of lamp replacements	$ 1.25 (d)	$ 2.05 (d)	$ .65	$ .75	$ 1.85	$ 3.00
	20. Cost of cleaning twice per year	$ 1.80	$ 1.80	$ 1.00	$ 1.00	$ 1.00	$ 1.00
	21. Total annual operating cost per luminaire (16 + 18 + 19 + 20) — 1c per KWH	$14.90	$22.90	$23.70	$32.55	$34.10	$54.00
	2c per KWH	$24.00	$37.50	$34.45	$49.75	$59.10	$94.00
	3c per KWH	$33.10	$52.10	$45.20	$66.95	$84.10	$134.00
	22. Relative annual operating cost for equal maintained footcandles (21 × 8) / (21 × 8) for column I — 1c per KWH	100%	100%	147%	131%	197%	202%
	2c per KWH	100%	100%	133%	123%	212%	215%
	3c per KWH	100%	100%	126%	119%	218%	221%
D	**Total Annual Costs**						
	23. Relative total annual cost for equal maintained footcandles (13 + 21) × 8 / (13 + 21) × 8 for column I — 1c per KWH	100%	100%	103%	103%	(h) 118%	140%
	2c per KWH	100%	100%	104%	104%	148%	168%
	3c per KWH	100%	100%	105%	105%	165%	183%

(a) For room index D — 50% ceiling, 30% walls.

(b) Includes mean lamp depreciation and mean dirt depreciation during life, with two cleanings per year.

(c) Does not include wiring costs.

(d) Includes one starter replacement (at 50c) for every two lamps replaced.

(e) Rated life at 5 and 10 hours per start, respectively.

(f) Ballast watts and cost given are half of 2-lamp values.

(g) Average for lamp lives given in item 2.

(h) Wiring requirements of filament lighting systems are much greater than for fluorescent or mercury systems. This should reflect in substantially higher initial (and, therefore, total annual) cost than shown here.

Initial Cost

The next step is to establish the net costs of procuring and installing the different systems. This is done in Section B. The following suggestions may be helpful:

Item 10 — Local contractors or the plant or building electrician can supply an estimated average charge per luminaire for hanging. These charges will depend on such factors as height, whether hung individually or in continuous rows, and other aspects of the installation.

In many analyses, complete wiring costs must be calculated in addition to fixture installation costs. No set rules can be given for estimating wiring costs per KVA — almost every case must be computed individually. Except where there is a great difference in the efficiency of the system (as in filament *vs* fluorescent lighting) wiring costs for lighting can be expected to be similar, and to have little effect on the net result, particularly since the amortization period for wiring is usually very long (often 30 years — thus a much lower amortization rate than for the lighting equipment). When systems do differ greatly in efficiency and wiring costs are not shown in the economic analysis, attention should be called to the probable increased cost of energy distribution for the less efficient system.

Item 11 — Lamp costs are shown to indicate the total "out-of-pocket" initial investment, even though they are later charged as an operating expense item.

Item 13 — As stated earlier, total lighting cost should be weighted with an appropriate portion of the initial lighting investment. Whenever an established accounting procedure suggests a reasonable figure to be used on an amortization rate, it should be followed. If there is no set procedure, as is often the case, the use of a 15 per cent write-off rate is suggested. Typically, this might represent amortizing the lighting system in 10 years, at 10 per cent per year, plus 5 per cent for interest, taxes, and insurance.

Note that lamp cost is not included in the write-off.

Annual Operating Cost

Section C gives the various operating charges per luminaire of each system under consideration. Annual energy cost, total operating cost and relative annual operating cost can each be a single value if burning hours per year and average cost of electric energy are known. In many cases, however, exact values are not known. Under the latter circumstances, the use of 2500 and 4000 burning hours per year (typical for one-and two-shift operation respectively in factories) and 1, 2, and 3 cents per kwh (typical of the range of energy rates encountered) is suggested.

Total Annual Cost

The total annual cost per luminaire is obtained by adding items 13 and 21. The sum for each system is multiplied by Item 8 to equate for equal illumination and then related to the reference system, giving the *relative* total annual cost. Most users will have greatest interest in this figure, although some who are budgeting either capital investment or operating charges may be more concerned with one of those two values. Of course, the most economical lighting system from the standpoint of over-all cost is not necessarily the one with either the lowest initial cost or the one with lowest operating costs.

Estimating Actual Dollar Costs

The conversion from the relative costs given in Table I to actual dollars for a specific installation of similar type is readily accomplished. These steps are involved for each system.

1. Divide the effective maintained lumens per luminaire (Item 7) by the footcandle level desired in service. The result is the number of square feet of lighted area per luminaire. This value determines the spacing.
2. Divide the total square feet of the area to be lighted by the square feet per luminaire determined in Step 1 above. This gives the number of luminaires needed for the particular footcandle level in service, and will likely be a fractional quantity.
3. Correct for the number of luminaires to be actually used. In large areas, this answer will be close to that obtained by Step 2 above. In smaller interiors, the relation of room dimensions to luminaire length and orientation may mean the use of slightly more or fewer units in order to achieve a desirable layout and proper appearance of the lighted room.
4. To obtain actual costs in dollars:
   a. Initial cost—multiply Item 12 by number of luminaires
   b. Annual owning cost — multiply Item 13 by number of luminaires
   c. Operating cost — multiply Item 21 by number of luminaires
   d. Total annual cost — add (b) and (c)

It should be noted that comparisons of total annual cost (in dollars) obtained from 4(d) will not be for identical footcandle levels if the number of luminaires computed in Step 2 above is different from the number of luminaires actually used (Step 3).

* * * * *

In addition to providing a convenient method for estimating costs and comparing systems, such analyses are useful in many other ways. They can be used to determine the effect of variables such as energy cost, lamp depreciation rate, frequency of cleaning, and whether a group or spot replacement program for changing lamps is more economical. It is hoped that use of a uniform method for making and presenting such analyses will help bring greater attention to these important factors of lighting costs, with resultant benefit to lighting practice.

DISCUSSION

JOHN J. NEIDHART[1]: Any attempt to establish some uniformity in the methods by which we present lighting data and analyses to users of lighting equipment is a welcome one, and I want to add my support to the authors in their general objective.

I am not entirely satisfied, however, with their omission of wiring costs as a part of Item 10. I agree that the effect on the net result will generally be negligible except in cases where the systems being compared differ greatly in efficiency. It happens, however, that a comparison of such systems is

[1] Westinghouse Electric Corp., Cleveland, Ohio.

more likely to be required than a comparison of systems nearly equal in efficiency. The very example that the authors have used for Table I compares sources differing greatly in efficiency. In this instance the footnote reference to that fact is satisfactory since the addition of wiring cost accentuates the difference. There are many cases, however, where the incandescent system may falsely appear to be more economical than the systems with which it is being compared because of the omission of wiring costs. A footnote explanation in such an instance would still leave the comparison clouded with doubts.

Admittedly, wiring costs are very difficult to determine and will vary throughout the country. There is very little data available today on these costs, and it seems to me that each of us should direct his efforts toward obtaining representative wiring costs for his locality. These costs should include all costs back to the panelboard. I know that they can be obtained because we have worked them out with contractors on many occasions. If we obtain and exchange such information we can all benefit.

If wiring costs are included, it will be necessary to determine the actual lighting layout for a given illumination level as a part of the basic data. Having done this it then becomes practical to base the comparison upon the entire systems rather than upon individual luminaires. Comparisons of total costs of any of the items will be thereby facilitated, and I think that these total costs are what the user wants to compare. Any differences in illumination should, of course, be removed in a final line comparing the total relative annual cost per footcandle.

G. W. Beals*: This paper is of interest because there is an urgent need for a standard method of preparing cost analyses that can be followed uniformly by lighting engineers. Such a standard method must be complete in critical data, fair in its comparisons, and have enough detail to indicate the calculation basis selected where more than one commonly used procedure exists. Most previous lighting analyses have not been taken too seriously because they failed in one or more of the foregoing essentials. This proposed method also fails by its indifferent treatment of wiring costs as an item of initial costs.

There can be no question that wiring cost is a part of total initial cost — it is always a major item and often the largest item. It is a critical item in a tabulation such as Table I, because it indicates the calculation basis where more than one commonly used wiring procedure exists. It cannot be omitted as in Item 10 of the table and certainly Item 12 is not total initial cost. It follows that Annual Owning Cost Item 13 and Relative Cost Item 14 are likewise incorrect and the comparisons unfair. It is far better to add any reasonable estimate of Wiring Cost per Luminaire to each column than to omit the item for the inadequate reasons given in the text.

Table I omits Wiring Cost per Luminaire, and on that basis shows that the mercury system of column 2 has a Total Initial Cost per Luminaire that is only 58 per cent of that of the fluorescent system of column 1. The incandescent system of column 3 is 21 per cent, with a footnote advising that this value is low. To a buyer with a limited budget, Total Initial Cost could well be the dominant factor in his selection, and the comparison shown in Items 12, 13 and 14 would give him a totally wrong impression.

Assume that the Wiring Cost per Luminaire is $50 per outlet, i.e., the cost of materials and installation labor of providing outlet boxes, conduit and wiring from the panelboard in this area with its 25-foot mounting height. It is a reasonable estimate that can vary either way. Add $50 to each column on the assumption that each luminaire is individually located. The mercury system, column 2, is now 70 per cent instead of 58 per cent, and the incandescent, column 3, is 45 per cent instead of 21 per cent.

Furthermore, in a system which can be installed and wired by more than one well-known and commonly used method, the method selected in the analysis will be indicated by showing the item of Wiring Cost per Luminaire.

In this analysis, if the fluorescent system, column 1, is installed in continuous rows, one outlet would serve as a service entrance for a maximum of nine luminaires on a 15-ampere circuit. At $50 per outlet, the Wiring Cost per Luminaire would be about $5.50, plus about $1.50 per luminaire for pulling and splicing wires throughout the row. For such a continuous row assembly, therefore, add $7.00 for wiring per luminaire to column 1, and add $50.00 per outlet for wiring per luminaire to column 2 and you will find that, in Total Initial Cost, the mercury system is practically equal to the fluorescent instead of 58 per cent of it.

E. H. Raddin*: The authors have presented an interesting analysis of lighting costs with sufficient refinements to cover most conditions encountered in service. There are some points in this presentation which merit discussion.

On Item 3 of Section A, they suggest that the use of manufacturers' published average wattage for fluorescent lamps be used rather than the nominal watts by which the public has identified fluorescent lamps since the time they first appeared on the market. I am inclined to disagree with this recommendation, in view of the confusion which would result and the inherent characteristics and tolerances which apply to fluorescent lamps and ballasts. For instance, the latest Federal Specifications for fluorescent lamps permit watts 5 per cent above rated, and the latest Federal Specifications for lamp ballasts permit a variation of plus and minus 7½ per cent in watts. These tolerances are much larger than the difference in Table I between "average watts per lamp" and the nominal lamp watts.

In view of this, as well as the change in watts which will occur due to variation in line voltage and the variable ambient temperature, it seems more practical to use the familiar nominal values of lamp watts for such things as lighting cost analysis.

We should bear in mind that the "average watts per lamp" used in Table I for the 400-watt mercury vapor and the 1000-watt incandescent lamp are nominal watts. Federal Specification watt tolerance for the 1000-watt incandescent lamp is 3 per cent, plus or minus.

When we consider all these variables, it seems unwise to confuse the customer and the lighting industry with the use of any rating other than nominal watts for fluorescent lamps.

If the average watts of fluorescent lamps actually deviate from nominal watts by more than a reasonable tolerance, the lamp and ballast manufacturers should get together and design their products to produce nominal watts.

*The Miller Co., Meriden, Conn.

*Chief Engineer, Champion Lamp Works, Lynn, Mass.

The authors use the terms "mean lamp output" and "mean depreciation due to dirt collection on lamps and fixtures" in their analysis. This is an encouraging sign and one with which we heartily agree, because it simplifies maintenance and light cost analysis to the point where consumers need not deal with values which vary exponentially. Our own extensive studies have been based on this same thinking.

GEORGE J. TAYLOR*: The need for standardization or following some specific procedure in computing lighting cost analysis has long been felt. Computing lighting costs at random very often leads to false conclusions and misrepresentation of the facts. In reviewing many lighting cost comparisons I have come to fully appreciate the old adage that — Figures never lie but liars can figure (no reflection on the authors of this paper).

Barr and Amick must have been gravely serious when they stated in their opening paragraphs: "Of course, cost comparisons exclude considerations of relative lighting quality which is of equal importance to quantity. Reports showing favorable economy for a lighting system which fails to provide comparable comfort should be accompanied by suitable explanations." Somehow the statement lacks suitable emphasis as written, when in fact it is the most important qualification of any cost study made. Assuming that appropriate lighting levels are provided the value of comfort of seeing (quality) is not merely of equal importance but many times more important than quantity. Let us never lose sight of that. Moreover, what is there to explain about a lighting system which may be economical but not comfortable? Nothing. If it is not comfortable it should not be installed regardless of cost. We are not serious enough about the true significance of comfortable lighting as a profession and that is bad. No wonder we have so many poor lighting installations and so few good ones. My remarks in no way offer a challenge to the authors' statements but are made as an extra precaution to readers. When some day we learn to evaluate comfort of lighting, then we can incorporate this in such tables as proposed by the authors, changing the title perhaps to "Lighting Analysis" which would then include comfort as well as cost.

Under the title "Cost Analysis Objectives," Point 1 it is stated that: ". . . all costs should be equated to an equal maintained footcandles basis." Obviously, we must consider this in our computations. Yet, it must be realized that this is a theoretical consideration and not practical. For example, in studies we made comparing several lighting systems for offices we found it necessary first to make practical lighting layouts for various size rooms. Then an adjustment was made for equal footcandles. One typical example of comparing two systems is of interest in this connection. In a room 40' x 60' the following conditions prevailed:

Practical Comparison

	System A	System B
No. of Fixtures	32	70
Calculated Footcandles	49.9	52.5
First Cost	$1958.91	$2167.44
Percentage	100%	110.7%

Theoretical Comparison

No. of Fixtures	32.06	66.64
Adjusted Footcandles	50	50
First Cost	$1962.83	$2063.40
Percentage	100%	105.0%

*Supervisory Lighting Engineer, Day-Brite Lighting, Inc., New York, N. Y.

If it was decided to *install* System B, the cost over System A would be some 10 per cent greater and not 5 per cent as the theoretical comparison shows. You just cannot throw dollars around like that in today's competitive market.

In the section of "initial cost," Item 10, wiring costs are not included and the reason is appreciated. Nevertheless, our studies show that there may be appreciable differences in wiring costs between fluorescent lighting systems. Wiring costs include cost of installing, panel boards, branch circuits, wiring in conduit (or equivalent), ceiling outlets and local switches. Modern lighting installations consider module layouts especially in offices for flexibility of control. In modern office design at least one switch per module allows for changes in partitions at any time. Based on this, we have found for a room 40' x 60' some interesting cost data as related to wiring.

	4 40-Watt louvered fixtures	2 40-Watt louvered fixtures	2 40-Watt luminous indirect fixtures	2 40-Watt aluminum troffers
Wiring Cost	$1427.00	$1182.00	$1328.00	$1212.00

This indicates that there can be as much as a 20 per cent difference in wiring costs between fluorescent office lighting systems.

We have also found that the wiring costs run as high as 20 per cent of the overall cost of many office lighting systems. Unless wiring cost is added to the analysis a true total cost of a lighting system is not presented. It is suggested, therefore, that an item be added to Table I titled "Building Wiring Cost."

We most certainly need a uniform method of presenting cost analyses of lighting systems as suggested by this paper. Owners, architects, engineers and all of us in the lighting industry would benefit because it would result in agreed conclusions. The authors have presented a splendid three-page *outline* on this important subject. Now let them write a 10 page paper including "Building Wiring Costs" and give a complete explanation of all vital items for the sake of clarity and understanding by all. A comprehensive paper on the subject would be a most valuable contribution to our industry.

A. C. BARR and C. L. AMICK*: It is gratifying that the discussors echo the need for greater uniformity in methods of analyzing lighting costs, even though a single typical example cannot, in its details, reflect actual costs for the wide range encountered in practice. This is particularly true of wiring, as several of the discussors emphasize. Hence our warning against assuming a figure instead of ascertaining values applicable to the particular installation.

Mr. Raddin expresses concern over our realistic use of average instead of nominal wattage of fluorescent lamps. This is simply recognition of the facts of an advancing art; any other course would be misleading. The facts of fluorescent lamp wattage are not readily altered, being subject to the characteristics of the operating auxiliaries on which the improved sources are necessarily used.

The present paper, as already stated, deals with only one of the factors in a lighting system. The comments on the importance of lighting quality, though not directly pertinent to our subject, are none the less praise-worthy.

*Authors.

Lighting a Recreation Room

LIGHTING OBJECTIVE: To provide a low level of general illumination and decorative lighting effects in a low-ceiling room used for entertaining and recreation.

Installation at Detroit, Michigan
Residence of John Rulketter.

General Information: The room is 29'6" x 12' with a 7-foot white ceiling. Walls are panelled in cedar (25% RF) from the floor to the lip of the cove. The inside of the cove and the upper wall match the white ceiling. The linoleum floor is a mottled dark brown (9% RF). Doors are painted vermillion red and the alcove backgrounds are painted a deep pink (45% RF). The furniture is bamboo. There are no critical seeing tasks carried on in this room; it is used primarily for relaxation.

Installation: The general lighting is accomplished by use of a fluorescent cove (deluxe warm) on two sides of the room. The window wells are all equipped with convenience outlets which are wall-switch controlled, and the centerpiece on the table is spot lighted by an adjustable 75-watt R-30 spot lamp located on the ceiling of the window well. A lumiline lamp (straw-colored) spreads a soft

Figure 3. Close up of bar and wall map lighting.

(over)

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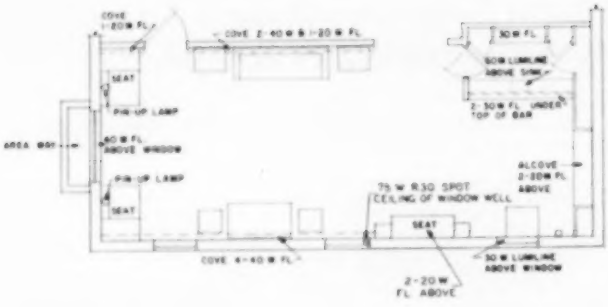

Figure 4. Plan view showing location of furniture and lighting equipment.

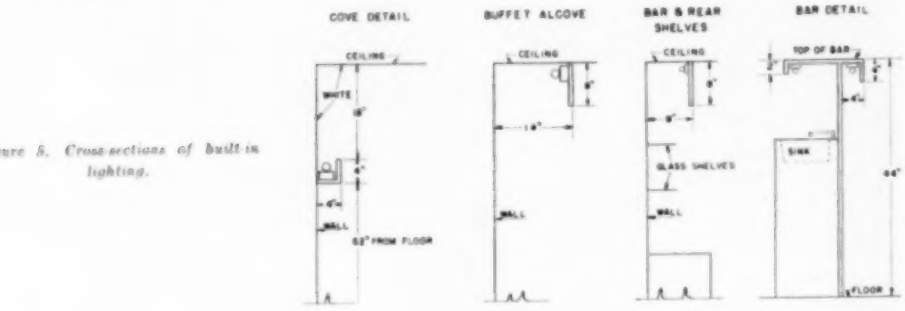

Figure 5. Cross-sections of built-in lighting.

glow of light down upon the homespun curtains. The north window area is ordinarily lighted by a 40-watt fluorescent lamp (deluxe warm) concealed behind the wood cornice. At Christmas this lamp is changed to a 40-watt black-light lamp that activates the aniline dye on the ornaments of the Christmas tree outside the window, creating a most interesting and decorative holiday effect. At the south end of the room attention is focused on the wall map by means of 2 20-watt fluorescent lamps (deluxe warm) concealed behind the cornice. These lamps also provide light for the buffet-shelf which is used for food service. A similar installation is used in the window seat alcove. At the bar, fluorescent lamps (2 30-watt 3500 K white, end to end) beneath a small cornice direct light down upon the wallpapered bar front. The glass shelves to the rear of this area are also lighted by 2 30-watt fluorescent lamps (deluxe warm) end to end. A single 60-watt white lumiline lamp furnishes light for dishwashing at the sink. Three 75-watt pin-up lamps add highlight and wall interest.

The resultant illumination with all lamps turned on is as follows:

	Footcandles
General room lighting	4 to 5
Centerpiece on table	50
Small table (pin-up lamp)	18
Sink (rear of bar), general lighting average	22
Sink (at faucet)	65
Bar top	9
Glass shelf (rear of bar)	17

The brightnesses measure:

	Footlamberts
Cove — wall 3 inches above lamp	195*
Ceiling and wall directly above cove	25
Ceiling approx. 42 inches from wall	15
Outer cove surface, cedar finish	3 to 4*
Ceiling center	3 to 4

The fluorescent channels were manufactured by the Roberts Manufacturing Company; wiring, wall panelling, and cove design by owner.

*A brightness ratio of 195 to 3 footlamberts is ordinarily considered too great for close visual work, but with lower levels of illumination, matte surfaces and recreational use the effect is found to be satisfactory.

Lighting data submitted by Mary Tuepke, The Detroit Edison Company, Detroit, Michigan, as an illustration of good lighting practice and to aid in the design of similar installations.

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The Lighting Engineer and the Architect

By LESSING WHITFORD WILLIAMS

ARCHITECTS deal in *form* and *function*. Both of these are inseparably linked with vision and therefore with lighting. Physical *form* may remain constant, but the visual impression of that form can change greatly with a change in the illumination. By controlling the light that makes the form visible, the architects may alter the apparent height or width, break up larger forms into smaller ones, or emphasize one portion against another. This has always been the case, but in today's simplified styles, often the lighting design actually *is* the interior design, and in every case lighting is of major importance.

Demands for the architect's time are such that even those who are particularly interested in lighting cannot keep abreast of the latest techniques and materials in this specialized field. Supplying such material is within the province of the lighting engineer. The demand is vastly greater than engineers seem to realize.

As the recipient of this information, the architect will be best served when the lighting engineer becomes a true consultant whose counsel is sought from the start of a design. Such a relationship will eliminate the all-too-frequent tendency to call in the engineer after the architectural planning is completed, a situation in which the scope of possible recommendations may be reduced to little more than hack work.

For a long time, architects have been accustomed to such a consulting arrangement with structural engineers, and more recently they have developed similar cooperation with heating and ventilating engineers. There is every reason why the relationship of the lighting engineer should be as close, or closer. While pressure of circumstances will eventually bring this about, the engineer himself, can do much to help speed the process.

Any conscientious architect is hungry for information. Anyone who can bring a single useful idea is sure of future welcome, whether he is a professional consultant or a manufacturer's representative. If the lighting engineer reconsiders his store of knowledge in terms of what the architect is trying to accomplish with lighting, and seeks opportunities to employ this information in working with the architect, the day of efficient cooperation will be hastened. In order to cooperate intelligently, the engineer should have some understanding of how the architect may have developed his own approach to lighting in design. A brief discussion of this background, as it concerns the conceptions of *form* and *function*, may be of help.

In the application of lighting to *form*, the architect's first analytical approach is in the geometrical study of shades and shadows, with practical use of this information in renderings and representative drawings. This knowledge leads to actual observation and study of the part played by highlights and shadows in the appearance of a structure. It is only a step from this to the realization that moldings executed in stone or wood look very different from the curves lines drawn on paper that accurately represent their profile. A later lesson in lighting comes with the recognition that a molding which is handsome in the sunny climate of Greece must be totally altered if it is to look right in the gray light of the Netherlands.

Examples of the effect of illumination on the visual appearance of *form* are found throughout the history of architecture; the mysterious effect of the Greek temple lighted only through a shaded doorway; the single great eye in the dome of the Pantheon in Rome; the airy effect of the dome in St. Sophia, supported on a ring of dainty windows; the solemnity and uplift of a church interior that is lighted only on the lower level with the overhead looming in darkness; or contrariwise the awesome effect of lighting in the tomb of Napoleon; the barren feeling that identical windows on opposing walls give to a living room though it may be beautifully designed and lavishly furnished.

From these instances where natural lighting has been a potent force in the esthetic appearance of a building or in the emotional reaction produced by it, the architect quickly learns that natural lighting is a basic factor in design. With the range of intensities and of sources available today, artificial lighting comes into its own as similarly basic in the creation of interiors with desired esthetic or emotional power, and the number of designs in which artificial lighting is so used is increasing.

Substance of a talk before the New York Section, I.E.S., January 15, 1952. Author: Architects, George B. Post Architects, New York, N. Y.

To cite just one example, in a large church with a broad nave, financial limitations restricted the height to something less than that called for by good design. A demonstration proved that intelligent lighting could counteract this structural deficiency. When a small amount of interior scaffolding remained to divide the interior into two equal areas ,the temporary lighting (consisting of bare bulbs with dishpans as reflectors) was arranged so that in one half the light was directed upward, in the other downward. As a result, the ceiling over the area with downward illumination, being half lost in shadow, appeared to be nearly six feet higher than that in the other area. With the downlighting which was ultimately installed, the church interior appeared loftier, more graceful, more impressive, and more inspiring.

In the illustration above, lighting was used both as a modifier of form and as a creator of mood. When these potentialities are combined with the vast possibilities in the use of color (which must be properly lighted) it is apparent that lighting is becoming one of the most important means of artistic expression at the architect's command.

In the application of lighting to *function*, the matters of quantity of light and the effects of glare and brightness contrasts have reached the architect more recently.

In the mid-twenties, an exhibit of period rooms was provided with a dual lighting system which permitted comparison between the customary lighting of the time and a level of 35 footcandles — almost unheard of then. Invariably, designers who viewed the exhibit preferred the conventional lighting. Yet they were not being merely conservative. Rather they were reacting instinct ively to considerations of lighting comfort which have only lately become better understood. These rooms had walls of dark wood, accents of silver and brass, and white ceilings. Their rich furnishings called primarily mood lighting, and the 35-footcandle system resulted in glare and in brightness contrasts above the threshold of tolerance. From similar experiences, some architects have become open-minded to the later developing theories of visual efficiency and comfort.

While research was seeking a scientific yardstick for human visual comfort and efficiency of lighting, most architects were trying to evaluate lighting installations by their personal reactions. Many are now alert to brightness contrasts, to direct, reflected, and veiling glare, and they realize that these factors affect not only eye comfort and efficiency, but also the appearances of color and of space relationships. They know too, that complete diffusion may interfere with three-dimensional seeing for which a directional component of illumination is necessary.

It is plain that lighting for both *form* and *function* is necessary in every lighting design, even though the project may be of a commercial or industrial nature. There must be a consideration of *mood*, or employee psychology, in the most efficient office, while the most utterly inspirational church interior yet requires that its lighting function. With an increasing multitude of tools to work with, architects want to know of them and to learn how to use them deliberately, precisely, and in full accord with both eye comfort and decoration.

In bringing his knowledge and talent to the architect, the consulting lighting engineer should present basic theory in simple form with the architect's limitations and interests in mind. He must free himself from slavery to mechanical efficiency as measured by the light meter and deal in real efficiency; the effect on human beings. He must be ready with counsel on paint reflectivity, brightness contrasts, the effects of glare, colors and color quality of light, and the psychological effect of light sources and their distributions — always with a keen consciousness of the varying importance of these factors within the requirements of the design problem at hand.

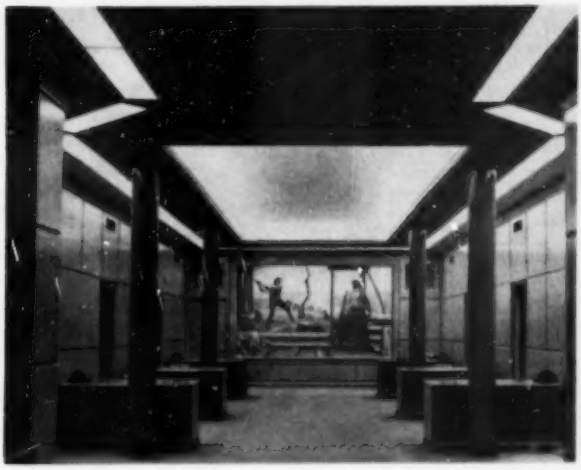
As the role of lighting in architecture grows in significance, architects have a vital need for the cooperation of lighting engineers who fully understand the problems involved and so can increase the designers' ability to use modern lighting techniques and equipment effectively and successfully.

Questions on Light Sources

The I.E.S. Committee on Light Sources, under the chairmanship of E. H. Raddin, is prepared to answer questions of general interest on light sources. Readers are invited to submit such questions to be considered for publication. Questions should be sent in care of Society Headquarters.

Lighting a Secretarial Ante-Room

LIGHTING OBJECTIVE: To provide illumination for secretarial work and on a mural, with a feeling of airy openness in a windowless room.



Installation at
Fidelity Trust Company
343 Fourth Avenue
Pittsburgh, Pennsylvania.

Figure 2. Close-up of combination fluorescent and incandescent mural lighting troffer.

General Information: Off this room are the private offices of the various trust officers of the company; each officer's private secretary is stationed outside his door, within the ante-room.

The room is paneled to the ceiling in natural-color prima-vera wood (40% RF). The carpet is gray-green (25% RF), ceiling is cream (70% RF), and the work surfaces are natural wood (50% RF). A colorful Malcolm Parcell mural covers the far end of the room.

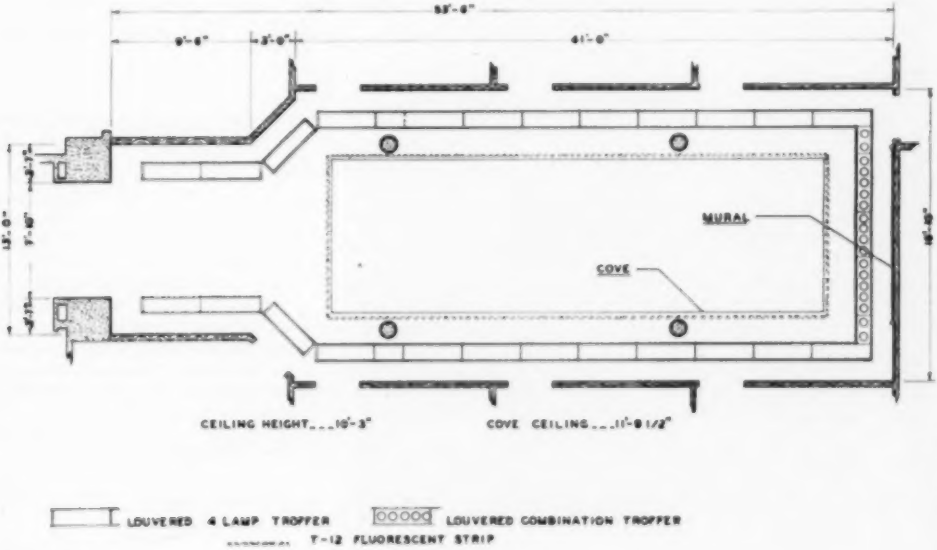


Figure 3. Plan view.

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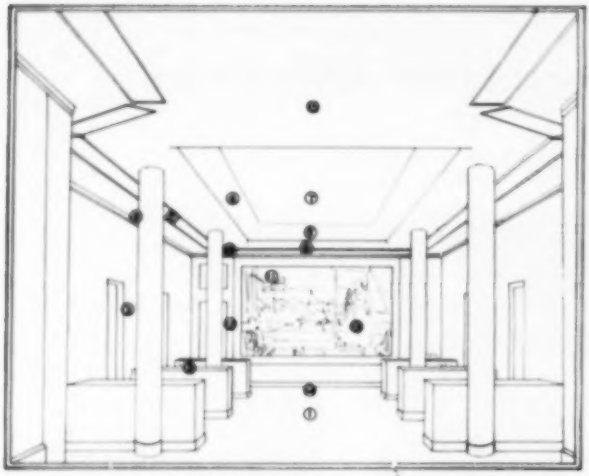


Figure 4. (Above left) Visitor's view; circled numbers are keyed to brightnesses given in the text.

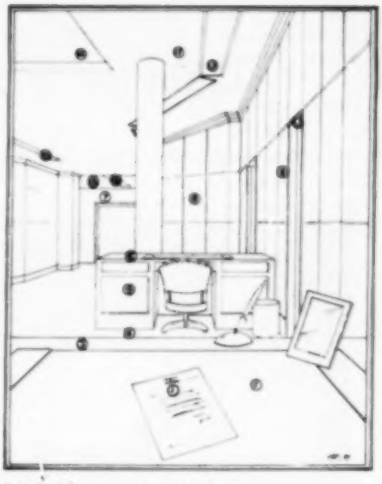
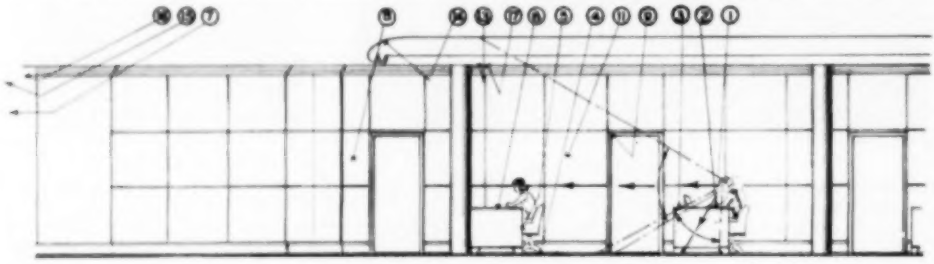


Figure 5. (Above right and below) Secretary's view; circled numbers are keyed to brightnesses given in the text.



Installation: The center of the room is illuminated by a white cove containing a continuous row of 40-watt T-12 3500K fluorescent lamps. Most of the general illumination is provided by 25 recessed Pittsburgh Reflector Co. No. PF-440-E troffers (shielded by No. ELE-12-40 louvers) each containing four 40-watt 3500K white fluorescent lamps. The troffers at the mural end of the room (covered by the same standard louvers) were designed especially for this installation; each contains two 40-watt 4500K white T-12 fluorescent lamps and five incandescent filament reflector lamp luminaires (Pittsburgh Permaflector No. 29) spaced on the face of the reflector within the troffer to provide even illumination on the face of the mural.

Average horizontal illumination 30 inches above the floor after 4000 hours operation was 40.4 footcandles; on the work surfaces it ranged from 44 to 60 footcandles. Vertical footcandles on the mural ranged from 21 to 37.

Brightnesses are as follows:

Visitor's View		Secretary's View	
Station No.	Footlamberts	Station No.	Footlamberts
1	6.6	1	48.0
2	12.2	2	7.8
3	11.5	3	16.0
4	7.4	4	4.6
5	450.0	5	3.5
6	87.0	6	7.5
7	14.7	7	6.5
8	130.0	8	7.5
9	17.0	9	25.5
10	149.0	10	240.0
11	34.5	11	2.5
12	8.8	12	440.0
13	33.3	13	6.9
14	11.5	14	175.0
		15	9.0
		16	210.0

Ante-room interior designed by Charles M. and Edward Stotz, Architect and Engineer, respectively, of Pittsburgh; lighting designed by J. S. Frizzell, Pittsburgh Reflector Company. Equipment installed by the Levinson Electric Company of Pittsburgh.

Lighting data submitted by H. D. Siler, Sales Engineer, and J. S. Frizzell, Illuminating Engineer, of the Pittsburgh Reflector Company as an illustration of good lighting practice and to aid in the design of similar installations.

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Lighting in Public Buildings

The Work of the I.E.S. Committee on Lighting Study Projects in Public Buildings and Private Institutions

[Some of the interests of this committee are demonstrated in this issue, which emphasizes particularly the application of lighting techniques in public buildings.]

The lengthy title of the committee is indicative of its extensive scope. Actually the committee is the coordinating body for the efforts of its four sub-committees. Specifically, the committee is directed to initiate, follow up and coordinate lighting study projects in the field of public buildings and private institutions, review the reports of the various study sub-committees in this field and make recommendations to the I.E.S. Council.

The four sub-committees are: Lighting in Auditoriums and Churches; Lighting in Hospitals; Lighting in Kitchens, Lunchrooms, Cafeterias and Dining Areas; and Lighting in Theatres. Since each sub-committee has ten or more different projects to investigate within its own scope, the intent is to confine the committee's efforts to the study of one or two particular assignments at a time. By so doing it is hoped to have completed reports on each particular area of a building long before a complete report on an entire building could be accumulated. For instance, the Lighting in Hospitals Committee would make a study and report on Patient Room and Laboratory Lighting before proceeding with the study of operating rooms, mental wards, waiting rooms, solariums, etc.

ROBERT S. ROGGE, *Chairman.*

Farmers National Bank, Pittsburgh, Pa.

In this high ceiling (25 feet) bank lobby, the architectural elements of the design have been utilized in the relighting plan, using 5-ft. and 4-ft. acrylic plastic panel luminaires, semi-recessed and spaced 15-ft. by 15-ft. center to center. Each unit contains 14 40-watt T-12 and/or 30-watt T-8 standard white lamps. The ceiling is white; walls are white and gray marble. Average illumination level is 25 footcandles after four months' operation. ***Photo and data courtesy of Rohm & Haas, Philadelphia, Pa.***

Toledo Central Union Terminal: Concourse Waiting Room.

Lighting well integrated with the architecture of the structure is achieved here. Semi-indirect coves along the side employ two rows of 40-watt fluorescent lamps and are supplemented with recessed luminaires, each equipped with two 40-watt fluorescent lamps except those opposite the exits to the track level. Here the center luminaire is equipped with ten 40-watt lamps while those on the sides each have four 40-watt lamps. All louvers are of the egg-crate type with 45° shielding. The concourse area is about 50' x 200'. ***Photo and data courtesy General Electric Co., Cleveland, Ohio.***

Lounge, Milwaukee Athletic Club, Milwaukee, Wis.

In this restful lounge general illumination is 5 footcandles, with 25 footcandles accenting the plants placed on glass-topped tables under two 500-watt ceiling spots. The cold-cathode coves which supply the general lighting are about 12 inches in depth and about 14 feet apart. Portable lamps supply local lighting at furniture groupings. Attention is drawn to the recess in the rear wall by an increase in brightness through the use of lighter-colored and different-textured materials and by the vertical surface supplementary lighting. The tan fiber wall is lighted with 6 40-watt T-12 soft white fluorescent lamps recessed above a baffle. Size of the lounge is about 70-ft. by 52-ft. with an 18-ft. ceiling. Ceiling is white, walls are wood-paneled and carpeting is warm tan on a parquet floor. *Photo and data courtesy of General Electric Co., Cleveland, Ohio.*

Christian Science Reading Room, Los Angeles, Calif.

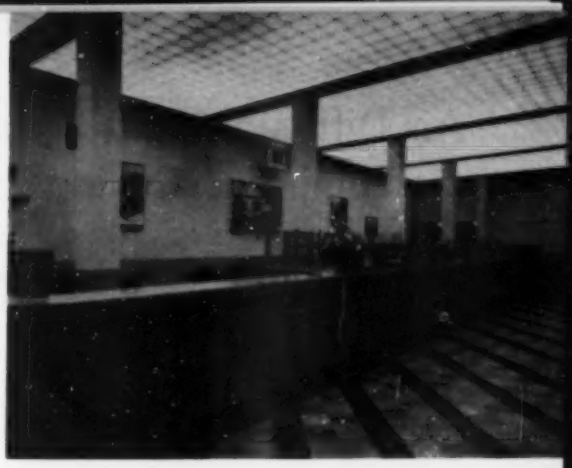
There are 31 egg-crate units with 300-watt silver-bowl lamps recessed flush with the acoustical ceiling on approximately 7-foot centers. Illumination from the ceiling units is 33 footcandles and table lamps provide supplemental lighting. The ceiling is white acoustical tile, walls are dark coral, and floors are cork tile. Furniture has a light finish, almost blonde. The panels seen on the rear wall are a combination of large glass panes of green-blue cast between which marine plants are simulated. *Photo and data courtesy of Department of Water and Power, City of Los Angeles.*

Curtis Hotel, Minneapolis, Minn.: Entrance.

A residential atmosphere was part of the aim in remodeling the entrance lobby here. Eleven recessed spots in the marquee are each equipped with 75-watt filament lamps, spaced 5′ x 6′. The cove just inside the glass entrance contains four luminaires each equipped with two 96″ fluorescent lamps. Illumination is eight footcandles on the steps and nine under cove inside. Ceiling around the cove is light green, cove is white, walls light green, floor and steps tan marble and vases are white. *Photo and data courtesy General Electric Co., Cleveland, Ohio.*

Imperial Bank of Canada, Winnipeg, Man.

The 17-ft. 6-in. ceiling is divided into five bays of equal size, in the large 34-ft. by 80-ft. banking area. Eight-foot single strip 430 ma instant start slimline lamps are ceiling-mounted in continuous rows on 3-ft. 6-in. centers. The louvered "tile" ceiling is suspended at a height of 14-ft. 6-in. from the floor. Illumination value after two months' operation is 40 footcandles average. *Photo and data courtesy of J. A. Wilson Lighting and Display Ltd., Toronto, Ont.*



Senate Chamber, New York State Capitol, Albany, N. Y.

Extensive renovations have been made in this legislative chamber with one of the major improvements the new lighting system. The problem was to provide adequate light without interfering with the quiet dignity of the room, and also to supply facilities for television photography. The principal source of light is five large pendent luminaires above the main floor of the Chamber and six similar but smaller units, three above each gallery. The large units are designed to give direct, indirect and diffused light. General illumination is about twelve footcandles over floor area. Supplementary lighting consists of 12 spotlights concealed above the coffered wood ceiling, used to accent the rostrum, and 46 downlights which cover the floor area. A system of dimmers makes it possible to regulate the supplementary lighting from zero to a maximum of about 60 footcandles. *Photo and data courtesy of N. Y. State Department of Public Works and Marcus T. Reynolds, Architects, Albany, N. Y.*

Trading Floor, New York Curb Exchange.

A special problem existed here, in that finger signals at a distance of 100 feet had to be recognizable but at the same time, general lighting could not interfere with the projected image of the moving ticker tape. Some 60 specially-designed 500-watt narrow beam downlights spotlight the counters. *Photo and data courtesy of Rambusch Decorating Co., New York, N. Y.*

Air Diffusion And Light Depreciation Tests Of Luminous Ceiling

By RUSSELL C. PUTNAM, ROLLIN W. WAITE, L. G. SEIGEL, and W. L. BRYAN

DURING 1951, tests of a luminous acoustical ceiling were run for the following purposes:

(1) to determine the volume of air which could be introduced into a room through the ceiling by using the space above as an air plenum;

(2) to measure the noise level due to air distribution from such a ceiling;

(3) to ascertain the depreciation of the lighting equipment due to dirt introduced into the plenum space along with the air.

These tests also provided information on the possibilities of drafts on room occupants and on the air pressures required in the plenum space to distribute various quantities of air through the ceiling to the room below.

By analyzing the above information, it was possible to determine the practicability of using the luminous ceiling as an air distribution system for comfort air conditioning and to estimate the effect of such air distribution upon lighting maintenance.

It was assumed that the corrugated acrylic plastic panels used in the ceiling would provide sufficient outlets at the ends for a volume of air that would assure adequate heating or cooling to room occupants. If such were the case, the ceiling would provide three to one brightness ratios in a properly decorated room by means of a large area low-brightness source, adequate acoustical controls,[1] and air diffusion at a volume in keeping with present air-conditioning standards.

Air Flow Test Unit and Procedure

Fig. 1 is a photograph of the 3-ft x 4-ft ceiling panel and Fig. 2 shows sectional dimensions of the panel. Fig. 3 shows a schematic diagram of the test set-up which was arranged for two ceiling units and one perforated acoustical baffle. The 4-ft x 6-ft x 2-ft plenum was equipped with lamps and was constructed so that the entire set-up should be typical of a commercial installation.

Air flow was measured by a calibrated orifice using two independent sets of gages and pressure taps. Two independent calibrated gages were used for pressure measurements, and the noise measurements were observed on two independent calibrated noise meters. The fan and motor were located at a distance from the test space to eliminate noise disturbance from those sources. The noise meter microphone was located 30 inches from the ceiling and outside the direct air jet, and these readings were repeated on all four sides of the installation, the average being recorded for plotting the curves. In no case was there any appreciable discrepancy between duplicate readings of air flow, pressure, or noise.

Results of Air Flow Tests

Measurements of the pressure required to supply air at various flow rates are summarized in Fig. 4. Three conditions of installation are indicated (A, B, and C) and in all cases the pressure drop varies as the square of the air-flow quantity which is to be expected for the turbulent range. For convenience, the pressure data are repeated in Table I with the air flow expressed as "cubic feet of air per minute per foot of exposed edge."

Results of the noise tests are shown in Fig. 5. The plotted curve shows the noise intensity level in decibels from an average of the two instruments used. The measurements were carried up to the point where a high-pitched whistle was observed. This point is far beyond the normal range of operation for ordinary ventilation and air conditioning. It was observed that the measured noise intensities were well below the corresponding levels for a typical air conditioning grille installation at like pressures.

In order to investigate the air distribution characteristics of the test ceiling,. measurements were made of the velocity of the air issuing from the ceiling openings, additional velocity measurements

A paper presented before the Great Lakes Regional Conference, I.E.S., Cleveland, Ohio, May 5-6, 1952. Authors: Consulting Engineers, Professors at Case Institute of Technology, Cleveland, Ohio. Profs. Putnam and Waite conducted the light depreciation tests; Profs. Seigel and Bryan the air flow tests.

1. "Light and Sound Absorption," T. D. Wakefield, pp. 567, 568, ILLUMINATING ENGINEERING, November 1951.

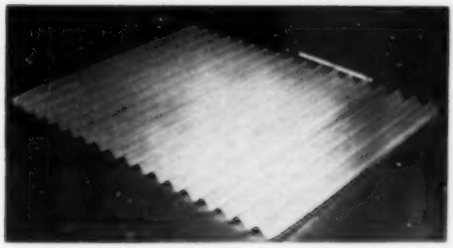


Figure 1. Ceiling panel.

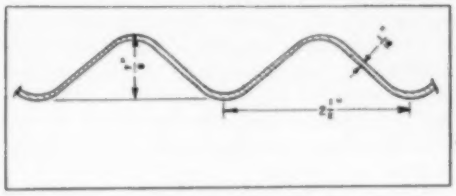


Figure 2. Sectional view of ceiling.

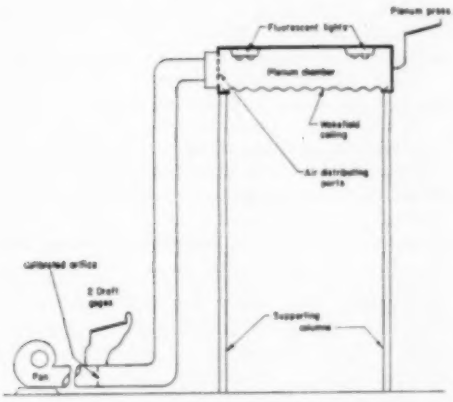


Figure 3. Schematic diagram of test set-up.

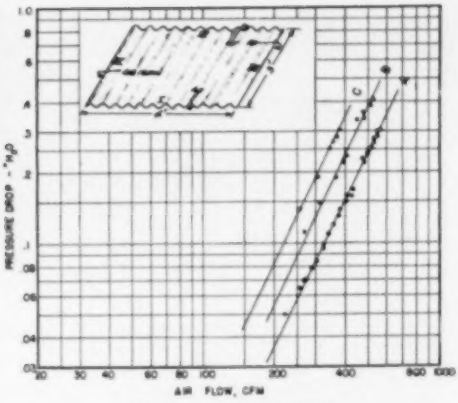


Figure 4. Air flow results:

A—All edges open as fitted in ceiling on standard hangers.
B—Edge IV blocked to prevent air flow.
C—Edges III and IV blocked to prevent air flow.

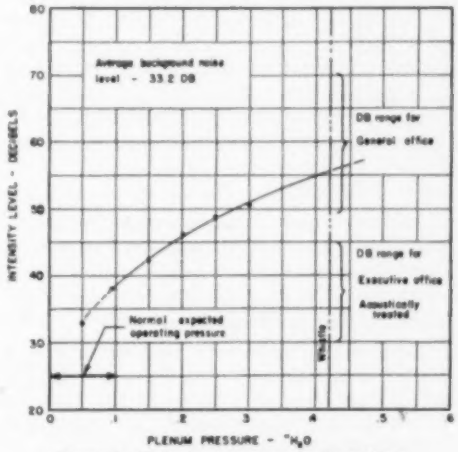

Average background noise level - 33.2 DB
DB range for General office
DB range for Executive office Acoustically treated
Normal expected operating pressure
INTENSITY LEVEL - DECIBELS
PLENUM PRESSURE - "H2O

Figure 5. Noise level for air supply ceiling.

were taken at various distances below the ceiling. The results of this investigation are shown in the schematic velocity distribution pattern of Fig. 6 which is for a high rate of air flow. Fig. 7 is a photograph of the distribution pattern obtained when steam was introduced into the air supplied to the plenum.

Light Depreciation Procedure

For the purpose of a light depreciation test, air was passed through the system at a rate of 10.4 cubic feet per minute per square foot of ceiling area in addition to the tests made for the air diffusion studies. This rate was maintained 24 hours

TABLE I.—Air Flow Characteristics of Corrugated Plastic Ceiling.

Plenum Pressure "H_2O	Air Flow — CFM per Foot of Exposed Edge	
	Corrugated Edge	Straight Wall Edge
.05	9.8	6.0
.1	13.7	8.6
.2	19.0	12.1
.3	23.1	15.0
.4	26.9	16.8

To illustrate the use of the table, assume that a room is to be conditioned with air distributed from a 12' x 16' ceiling. In this application there may be 8 corrugated edges, each 16 feet long and 2 straight edges, each 12 feet long. Assuming a plenum pressure of .10 inches of water, the air flow through the ceiling would be:

for the corrugated edges, $8 \times 16 \times 13.7 = 1750$ cfm
for the straight edges, $2 \times 12 \times 8.6 = 206$ cfm

Total for all edges 1956 cfm

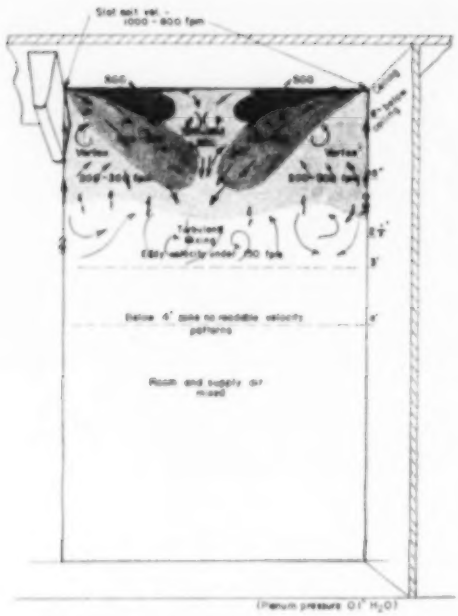


Figure 6. Schematic velocity distribution from ceiling.

per day for 14 days. Normal rate of flow is approximately one quarter of this rate, and therefore the total air quantity handled was equivalent to two months of continuous operation, or four to five months of daily operation.

The tests were made near a large industrial area in Cleveland, Ohio. Since no filters were used in the air system, the air pollution in these tests was more severe than would normally occur in practice.

Illumination measurements were made after the air quantity specified was passed through the system. Data were taken before the panels were cleaned and immediately after the panels were cleaned. Using this technique, it was assumed that after cleaning, the panels were in the same condition as existed prior to the start of the tests. Therefore, only the depreciation of the ceiling panels was determined; depreciation of lamps, light fixtures, or other associated equipment was excluded from the measurements. The ceiling panels were cleaned using recommended procedures.

The luminous ceiling panels and light fixtures were mounted in an enclosed box, about six feet from the floor. For the illumination measurements, a table was placed under the ceiling, with the table top about three feet below the ceiling (Fig. 8).

TABLE II.—Results, Illumination Tests.

Instr. No.	Instrument	Units	Value Before Cleaning	Value After Cleaning	Change Per Cent
A	Weston Illum.	Ft-C	33.2	33.2	0
B	Weston Illum.	Ft-C	30.9	30.9	0
C	Six Unit Light Cell	Ft-C	33.0	33.0	0
D	GE Lightmeter	Ft-C	25.5	25.5	0
E	GE Lightmeter	Ft-C	26.0	24.5	—5.8
F	GE Lightmeter	Ft-C	25.5	25.5	0
G	GE Lightmeter	Ft-C	32.0	32.0	0
H	Mag. Oxide Plate	Ft-L	49 (Av)	49 (Av)	0
I	Mag. Carb. Block	Ft-L	46 (Av)	45 (Av)	—2.2
J	Mag. Carb. Block	Ft-L	47 (Av)	45 (Av)	—4.3

All instruments were placed on this table, and during the cleaning of the ceiling, the instruments were not disturbed. Therefore, each measurement was made at exactly the same point before and after cleaning. All illumination measurements were made the same evening with no light present other than that from the panel of the luminous ceiling.

The types of measurements and instruments used were:

Brightness of a magnesium oxide plate—Luckiesh-Taylor Brightness Meter.

Brightness of two magnesium carbonate blocks—Luckiesh-Taylor Brightness Meter.

Illumination Level—two Weston Illuminometers, Model 603, each color corrected and cosine corrected.

Illumination Level—a six-cell, color corrected, cosine corrected light-cell, with an external microammeter.

Illumination Level—four General Electric Lightmeters.

Results of Lighting Test

In seven out of ten cases (Table II), the readings were exactly equal before and after cleaning the ceiling panels. In the other three cases, the data show a slight decrease in the illumination level after cleaning. In one of these cases (E), it may be assumed that there was an error in the reading

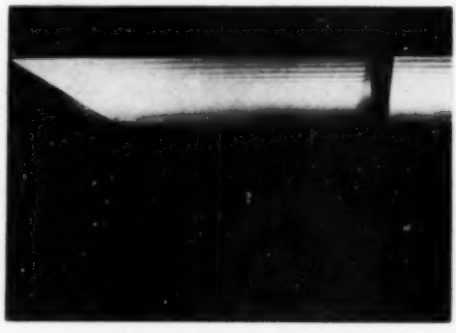


Figure 7. Air distribution.

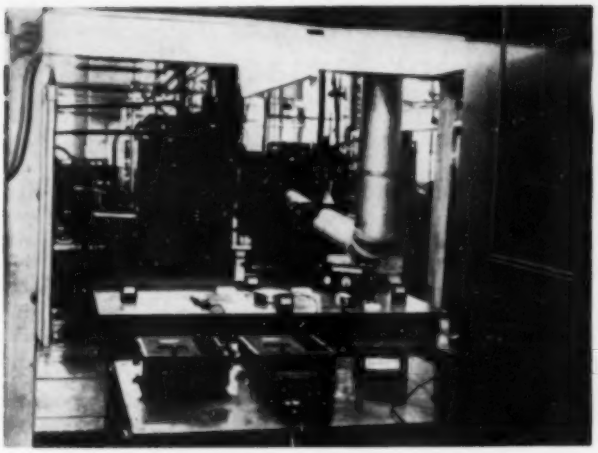


Figure 8. The position of the ten instruments used to measure the relative light output of the luminous ceiling panel.

of the meter, since three similar meter readings were constant. In the other two cases (I and J), the difference in readings may probably be attributed to the inherent limitation on the accuracy with which brightnesses may be determined with the brightness meter.

Conclusion

The results of the lighting tests of the luminous ceiling indicate that there was no measurable decrease in illumination level as a result of depreciation of the ceiling panels through the accumulation of dirt particles on the panels when air is passed through the plenum space for ventilation.

When heated or cooled air is used as may be required in air conditioning systems, the effects of thermal precipitation of dirt may be important. The tests reported here were run under isothermal air conditions and with a rate of air flow greater than used in many applications.

The air diffusion studies indicated that the luminous acoustical ceiling can be used to deliver an ample quantity of air for ordinary ventilation or air conditioning requirements, and that neither the pressure drop nor the noise level resulting from air flow are excessive. Since the air is delivered to the room through many narrow slot-shaped openings at ceiling height, a rapid rate of diffusion and mixing are obtained, and the possibilities of drafts are minimized.

These tests combined with previous papers on the luminous ceiling[1,2] indicate that engineers are now able to provide a single system for well distributed light at recommended lighting levels, sound absorption to control reverberation, and well diffused air.

1. *Luminous Ceiling for Offices*, Russell C. Putnam, ILLUMINATING ENGINEERING, Vol. XLVI, No. 8 (August 1951).
2. *Light and Sound Absorption*, T. D. Wakefield, ILLUMINATING ENGINEERING, Vol. XLVI, No. 11 (November 1951).

Installations to See in Cleveland

A list of interesting lighting installations in Cleveland has been compiled by the Cleveland Section of I.E.S. This list, with information on what hours to visit them, the possibility of guided tours, and where to find them, is given on page 24A of this issue. Whether you are in Cleveland for the I.L.E. or even if you live there (few people in New York have visited the Statue of Liberty) you will be interested in going around and taking a look.

Measurement of Pavement Surface Characteristics

By JOHN O. KRAEHENBUEHL

The investigation was undertaken to develop methods for determining the surface reflectance from a pavement. A special reflectometer was developed and studied for accuracy and the removal of all extraneous effects. To determine the value of the measurements made, suggested methods of presenting the data are discussed.

THE INVESTIGATION on pavement surface measurement was undertaken at the request of the Street and Highway Lighting Committee of the Illuminating Engineering Society. The problem was to develop a means of making reproducible photometric measurements of the reflecting characteristics of representative pavement surfaces, new and worn, wet and dry, with and without configurations, for all angles of incident light, and all angles of reflected light.

Object

Preliminary investigation of the surfaces of pavements indicated that many point readings with various positions of light source, pavement, and observer are necessary to describe the characteristics of the pavement surface, which represents a mixture of diffused and specular reflection. Methods previously used were time consuming in data taking and recording. One purpose is the development of a reflectometer which will rapidly measure the reflectance at a desired point in space with the degree of accuracy obtainable in making measurements of the reflectance by other instruments. Another goal is to present the data in a compact and understandable form for comparison purposes.

Objective data in conjunction with the subjective information obtainable would permit of a specification of the pavement surface as to its performance under actual working conditions.

The paper treats the first objective and suggests some methods of presenting the information which has been obtained from the measurement of pavement samples.

Shown in Fig. 1 is a photograph of the reflectometer, which is a form of goniometer, which was constructed for the measurement of the light emitted in space from a sample one foot in diameter.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, August 27-30, 1951, Washington, D. C. Author: University of Illinois, Urbana, Ill. Work done under Project 222 of the I.E.S. Research Fund. A progress report.

Figure 1. Automatic recording reflectometer.

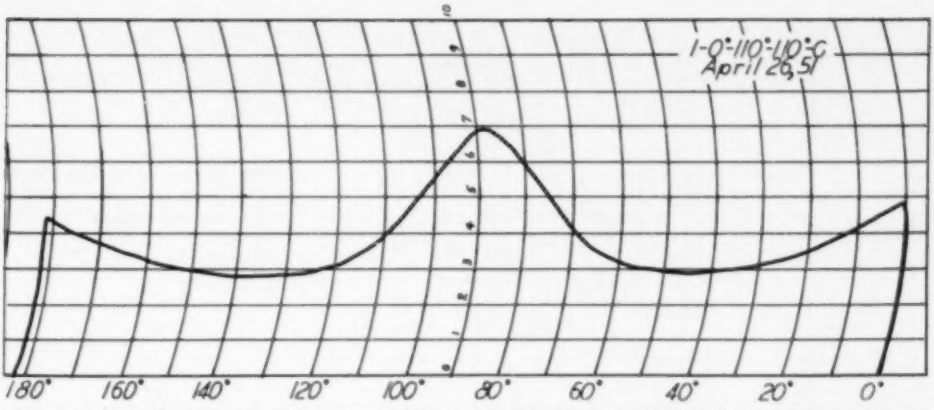


Figure 2. Typical record of automatic recording potentiometer. Ordinates in millivolts, full scale millivolts from 0.25 to 100 designated by multiplier tap *A* to *K*.

Legend 1 Sample number (wire broom finish)
0° Angle of sample rotation (δ)
110° Latitude of Source (γ)
110° Latitude of Cell (β)
C Scale multiplier
The curve represents longitude of the cell millivolt readings.

Measuring Equipment

The cell (*A*), which represents the observer, has freedom of movement in the vertical plane and rotates in a horizontal plane with the center of the specimen on the vertical axis line. The source (*B*), a 600-w, 450,000 maximum beam candle, (horizontal spread 12°, vertical spread 9°) military spotlight with an operating voltage of 24 volts has freedom in the vertical plane only. Under test the lamp is operated at approximately 20 volts. The specimen (*C*) is free to rotate around its axis, in the horizontal plane.

With this equipment it is possible to take readings at any point in the hemisphere above the specimen. The position (in latitude) of the cell, the latitude of the source, and specimen orientation are set manually for any unique solution of the problem while the particular trace for the readings at the various longitudes of the cell is recorded by an automatic photoelectric potentiometer recorder (in the remainder of the paper called the "recorder") as the cell moves in a horizontal plane. Fig. 2 shows a typical recording made by the recorder for the surface of a specimen of new wire broom finished concrete pavement.

The drive motor (*D*) for the cell arm is a worm speed-reduction series motor which moves the arm slowly in the direction in which the readings are being taken, with a rapid return when the motor is reversed. It requires one minute for the arm to travel forward and 20 seconds for it to return to the initial position, a 180° travel. The starting and stopping points are controlled by the limit switches (*M*) which are adjusted to the angular readings on the recorder paper. The arm is driven through a cable which is taut on the driving side with the slack removed on the opposite side by means of a spring inserted in the cable.

The motor is controlled from position *E* where the recorder (*F*) is located. The recorder paper drive is attached to the rotating arm supporting the cell, through a cable arranged in a similar manner as the one on the motor drive. The drive wheel on the recorder is so proportioned that divisions on the tape represent 10° or a total of 9 inches for 180 degrees. The wheel drives through a clutch so that the recording paper is released on the return trip of the arm. The paper is kept taut by means of a weight attached to the paper, keeping it under tension.

Fig. 3 shows the circuit diagram for the controls and the supply for both the lamp and the recorder. The transformer (*G*) is supplied from a line with a voltage regulator. The voltage on the lamp is set with a variable autotransformer (*H*) and a voltmeter, line variations being automatically adjusted by means of the regulator. To insure independent voltage control on the recorder a second regulator is placed in the supply line to the instrument. This is necessary when the recorder is working on the more sensitive ranges.

The equipment is constructed of pipe and structural steel elements properly bent and welded to-

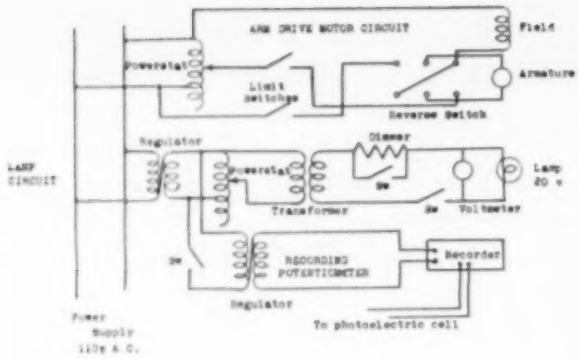


Figure 3. Circuits and controls for the arm drive, lamp, and automatic recording potentiometer.

gether. This provides a cheap and light weight structure; however, this type of structure sacrifices alignment which may be obtained with massive and accurately machined supports and surfaces. The inaccuracies may be eliminated by bracing and adjustments.

The light source is mounted on a three-point suspension which permits the positioning of the light accurately on the specimen, even though the track along which it moves fails to represent a smooth and true surface. The source is 60 inches from the specimen and the cell 45 inches from the surface. Since both move on the arc of a circle with the centers on the center of the surface of the 12-inch specimen both are always an equal distance from the center of the sample regardless of the angular position.

Manipulation

The specimen is placed on the stand (*C*) and leveled with a spirit level, then firmly clamped in position by four holding screws. The datum plane and the pavement sample surface are brought together by means of the elevating screw (*I*). The datum plane is established by means of a #18 piano wire tightly stretched between two holes in the source are which mark the 90° longitude positions. Where the surface of the sample is irregular the adjustment is made by bringing the highest points on the surface to the datum plane.

The military spot (*B*) has on its surface three points on the corners of an equilateral triangle framing the monogram stamped on the lamp. A target templet is placed on the specimen and the monogram and point images are properly positioned on the target by an optical system (*J*) which is then removed. It is necessary to target the source correctly for the light distribution in the beam of the spot is not uniform and even special lamps built with efforts to correct this defect have not proven good enough for accurate reproduction of results without properly placing the spot beam. Before each run a check is made on a control in which voltage and position adjustments of the source are made for the reproduction of a standard curve.

When taking curves where the cell is facing the source, (normal driving position) all interreflections have been eliminated. Shield (*L*) eliminates the reflectance from the side of the specimen when the cell is in the position of the region of zero and 180° longitude. Zero position is to the right when facing the source and on a line normal to the plane of the arc supporting the source.

The shield (*L*) must be kept in position at all times but must be changed in shape. The black cloth is supported on a wire frame which may be bent as desired. The shield (*K*) must be in position for low angles of the source only, to eliminate the direct radiation of the source into the cell. Holes in the shield (*K*) allow of various positions for the shield (*K*) depending upon the position of the source. The back of this shield (*K*) has an arrangement of baffles to eliminate the reflections from the specimen to the shield to the cell. It has been found that painting surfaces with flat black paint is not sufficient to eliminate serious interreflection effects.

When readings are to be taken from the side of the source it is necessary to have two curves, (1) a base curve which represents the readings obtained when a nonreflecting surface is in the holder, and (2) a curve when the sample is in the holder. The difference between the two curves represents the curve for the 180° to the 360° positions (the lamp removes approximately 8 degrees).

Measurements

The cell (*A*) is color corrected but not cosine corrected since the cell, in all positions, is normal to the radius from the center of the specimen surface.

Figure 4. Iso-footcandle plot for specimen with source latitude (γ) 110°. New concrete wire broom finish.

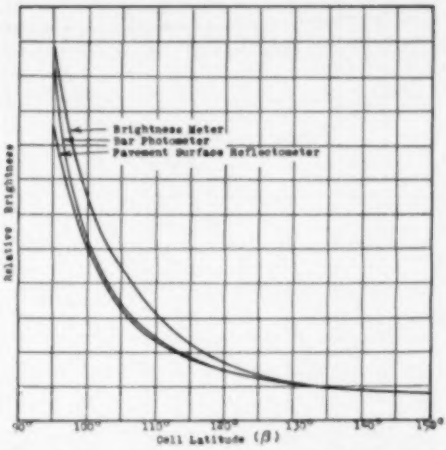


Figure 5. Comparison of results obtained when measuring an MgO disc by three methods. Source latitude (γ) 96°.

Color correction is desirable because various colors of usual pavement and colored specimens are to be studied. The solid angle subtended by the cell is controlled by a shield with baffles so placed that when the cell is at latitude 180° the sample, 12 inches in diameter, is covered by the cell.

The intensity of the source has been increased so that only one cell is necessary. Using one cell makes the angular deviation from the center of the cell very small. The closer the cell approaches a line in the width dimension, the smaller the angle increment, at grazing position, that may be measured and these positions are the more critical.

The matching impedance used with the cell is kept low so that the cell reading is linear with respect to the illumination which falls upon its surface. The sample cannot be treated as a point source but must be treated as a surface source which is circular in section with a diameter of 12 inches and whose center is always 45 inches from the cell face.

The curve taken, as shown in Fig. 2, is completely described by five dimensions and specific points by a sixth. Table I gives the values and legend used for the five dimensions depending upon the sample, angular settings of cell and source, sample rotation and scale used on the recorder multiplier. The sixth value is obtained from the curve and as many may be taken as desired.

TABLE I.—Data Taken for Each Sample and Sample Legend.

Sample	Cell Longitude	Cell Latitude	Source Latitude	Sample Rotation	Meter Scale Factor
	(α)	(β)	(γ)	(δ)	
Any Number	Number Desired	91°	92°	0°	A-0.25
		92	97.5	22.5	B-0.5
		93	100	45	C-1
		95	110	67.5	D-2
		100	120	90	E-3
		110	130		F-4
		130	140		G-5
		170	150		H-10
			160		J-50
			170		K-100
Sample legend Figure 2.		1	0	110	110	C
		Sample	δ	γ	β	Scale

80 curves per sample position.
400 curves for complete sample rotation.

Results

With the lamp operating at approximately 20 volts, to increase its life and to reduce the possibility of serious output variations during the run, curves are taken on the automatic recording potentiometer. The scale factors on Table I represent the full-scale millivolt readings. From the curves the millivolt reading of recorder, which in turn may be evaluated in microamperes delivered from the cell, may be read and these readings may be interpreted in footcandles per microampere. The apparent brightness may be calculated, considering

TABLE II.—Legend for Figures 6, 7, 8, 9.
Sample, New Concrete — Wire-broom Surface.

Figure	Rotation of Sample (δ)	Cell Latitude (β)	Source Latitude (γ)	Cell Longitude (α)
6	0	variable	110°	variable
7	0	variable	110°	variable
8	0	variable	variable	90°
9	variable	variable	110°	90°

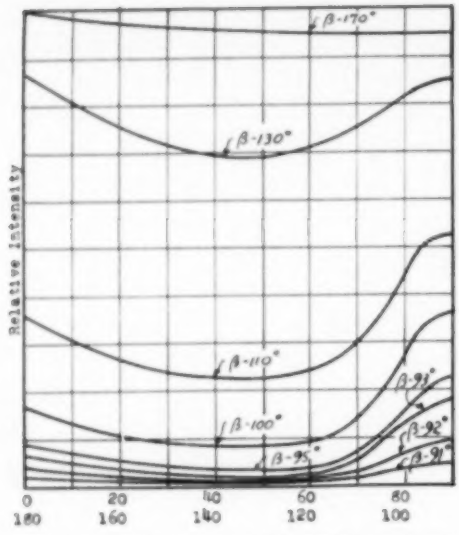


Figure 6. Relative intensity in terms of cell longitude.

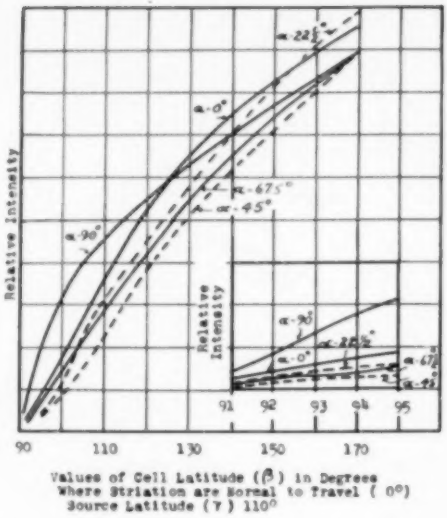


Figure 7. Relative intensity of sample viewed from various angles with the light source in a fixed position.

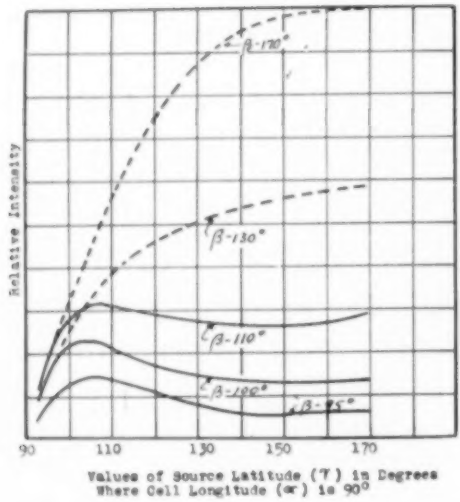


Figure 8. Relative intensity of sample as a function of light source position.

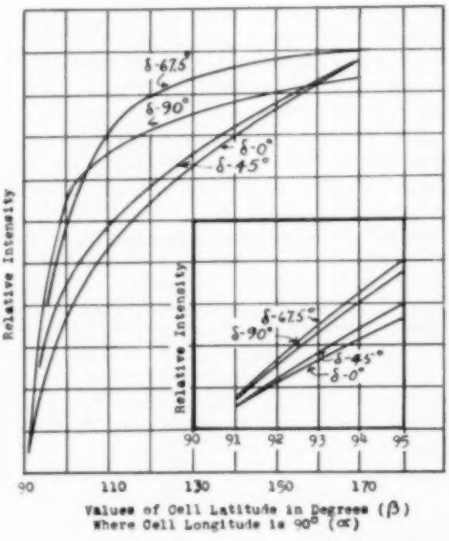


Figure 9. Rotation of the surface striations with respect to the observer, when the source is in a plane with the observer; $\frac{\gamma}{2} = 0°$ when the striations are normal to the plane of the observer and the source.

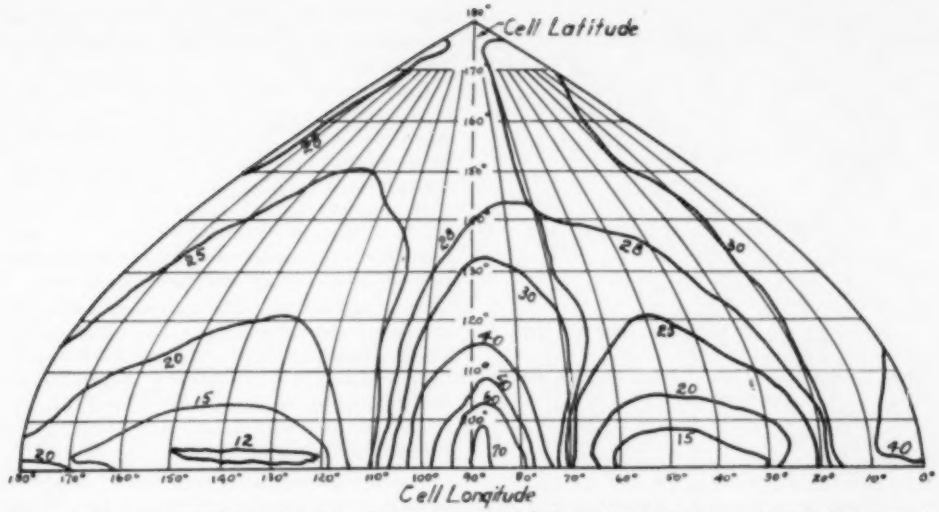


Figure 10. Iso-brightness coefficient plot with source latitude (γ) 110°. Data plotted on a sinusoidal web. New concrete wire broom finish. Brightness coefficient values in percentage.

a diffused surface source of circular section. Though the absolute values are available comparisons may be made on the basis of relative deflections of the recorder as both the recorder and the cell response are linear.

For the determination of a brightness coefficient it is necessary to determine the illumination falling upon the specimen. To obtain this value the surface of the specimen was explored by means of a small cosine corrected barrier-layer cell. The average illumination is determined by averaging the illumination values from an isofootcandle curve (Fig. 4) at uniformly spaced points on the sample.

Before taking data on the constructed reflectometer (Fig. 1) it was necessary to determine if the equipment would give results corresponding with other standard methods of measuring the effect of the reflected light. An MgO disc, 12 inches in diameter, was prepared following the standard procedure of smoking. This was measured in both the reflectometer and on a precision bar photometer. Fig. 5 shows a comparison of the results, after they have been reduced to a percentage base, as the sources in both instances were of different intensities. As a matter of comparison a brightness meter was mounted in place of the cell in the reflectometer to measure the brightness of the surface under the same conditions as the cell was used and the results are reported in Fig. 5.

Figs. 6 through 9 represent a study of a single pavement sample, new concrete wire-broom finished surface, plotted from the 400 curves taken on the sample in the quarter of the cells sphere surface above the equator and facing the light source. These represent only isolated plottings and a complete compilation in each instance would represent at least 10 curve sheets which would be beyond the scope of a paper on methods of measurements and presentation of data. Such data would belong in a paper on analysis.

Comparison curves could be drawn between the distribution from a diffusing material, such as MgO, and the specimen under study or the comparison of solid angles included between various percentages of light emittance from the surface. By this latter method a pavement sample might be specified as the solid angle covered by areas of constant percentages of emittance. Actual plots on the pavement of the distribution obtained from sinusoidal webs could be considered.

In Fig. 10, on a sinusoidal web, are plotted the brightness coefficients of the pavement for one source position. Ten of these webs would apply to any one sample with the ten source positions listed in Table I. The brightness coefficient as defined by J. Bergmans (The Brightness of Road Surface Under Artificial Illumination — Philips Technical Review, Vol. 3, No. 11, Nov. 1938) is the ratio of B' (footlamberts) to E (footcandles). The B' is calculated from the recorder curves obtained with the reflectometer and is the "apparent brightness" or "diffused brightness" since constant brightness (at all cell angles) was assumed in calculating illumination from a circular source E is the average illumination on the surface obtained from the isofootcandle plots similar to the ones in Fig. 4. The

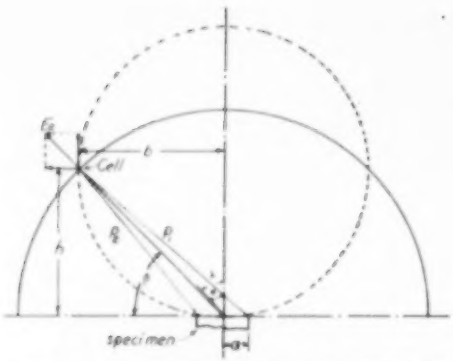


Figure 11. Reference figure for determining the relationship between B' and E_c.

apparent brightness for each source latitude γ and each cell latitude (β) will be different; however, the illumination at each source position need only be determined once. The coefficients for the cell position once determined may be used correctly on any curves taken.

To determine the coefficient to apply to the illumination read by the cell (E_c) for "apparent brightness" (B') reference is made to Fig. 11.

$$B' = \frac{c^2}{a^2}\left[\frac{c^2 - d^2}{c^2 - b^2}\right]^{1/2} E_c = K E_c$$

where $\quad c = \frac{1}{2}(p_1 + p_2), \; d = \frac{1}{2}(p_1 - p_2)$

or $$B' = \left[\frac{b^2 (p_1 p_2)^2}{b^2 (a^2 - d^2)^2 + h^2 d^4}\right]^{1/2} E_c = K E_c$$

where $p_1 = \left[h^2 + (b+a)^2\right]^{1/2}$, $p_2 = \left[h^2 + (b-a)^2\right]^{1/2}$

since the deviation of the angle θ from the angle λ is small for the proportions of the sample diameter to the distance of the sample from the cell.

When the reading taken from the curve is multiplied by a constant it becomes footcandles or $E_c = K'$ (ordinate of curve), therefore $B' = K'$ (ordinate of curve in millivolts). The value of K' may be determined for each cell latitude (β).

Conclusions

A reflectometer has been built for measuring pavement or any other specimen 12 inches in diameter, in three dimensions, with an accuracy equivalent to that of other devices for measuring samples of smaller size. The results obtained are consistent and there is little need of smoothing the data obtained.

The data obtained need not be of interest to the street and highway group only, for the characteristics of the landing strip surface in aviation are as vital as street and highway surfaces for the traffic it must carry.

A study of the data in the usual two-dimension form shows its inadequacy as compared to a three-dimensional study. The street and highway group found this out early in its deliberations and the sinusoidal web, for plotting the characteristics of a street luminaire is in common use. Since it is a space condition that is under study it would seem reasonable that space presentation would yield more information than would a projected trace.

The question could be brought up as to whether it would not be better to plot space information on a semi-sinusoidal chart (cylindrical web) than on the conventional web. Such a plot, though it would not yield any information not obtained from the sinusoidal web would more nearly follow normal convention of using cartesian coordinates.

It is now possible to accumulate large quantities of information concerning reflecting surfaces and the immediate need is some form of specification which will describe the requirements adequately in one or a number of coefficients. As in the instance of color, which produces a complex visual sensation, and has an objective specification, it may be possible to establish such a specification for a pavement surface. Color specification had to wait until there was a means of rapidly obtaining spectral curves; the reflectometer permits the rapid taking of curves for surface samples.

Acknowledgments

Where equipment must be designed and constructed and large amounts of data taken the results are obtained through team work by a number of individuals. In making available the material for preparing this paper the services of graduate and undergraduate students were available and two theses were written based upon phases of the development of the investigation.

Mr. H. H. Wilson did the initial work on the methods of measuring, investigating the reliability and sensitivity of the cell and meter arrangements, Mr. D. Burgner and Mr. A. H. Russell followed closely the design of the equipment and the comparison of the results obtained using the reflectometer and standard methods. Mr. Russell prepared a thesis on the study of the reliability of the equipment for making measurements. Mr. A. L. Hart spent time in eliminating interreflections and checking the reproducibility of the equipment. Mr. D. R. Phillips coordinated all these efforts and obtained the data used in preparing the paper. Mr. H. N. Tarnoff devoted his thesis work to the study of presentation of data by using brightness co-

efficients. The concrete sample used was furnished by the Portland Cement Association through Mr. A. A. Anderson.

Bibliography

Frequent reference was made to the bibliography appearing in the paper "Pavement Texture and Brightness — Part I" by F. D. Wyatt, ILLUMINATING ENGINEERING, Vol. XLIII, No. 10, p. 1331 (December 1948).

DISCUSSION

COMMENTS OF RESEARCH SUBCOMMITTEE OF I.E.S. STREET AND HIGHWAY LIGHTING COMMITTEE

Coefficient of Brightness. — Professor Kraehenbuehl's report defines and uses a term called the "coefficient of brightness." Since many street lighting engineers are not familiar with his term, and since it appears in the final charting, the following further comment might be helpful.

A pavement sample, for a given amount and angle of incident light, has a brightness which differs for various angles of viewing. Since the object of the measurements is to evaluate the variations in brightness throughout all angles of viewing, it is necessary to have a multiplying factor by which the incident light can be related to brightness. A given multiplying factor applies to a particular viewing direction and a particular angle of incident light.

The term "reflection factor" may not be a proper one to use in this case. Reflection factor means the ratio of the *total* light reflected to the *total* incident light. The quantity desired is the ratio of the brightness in the particular viewing direction to the total illumination *from the particular incidence direction*. Such a ratio may be called a "coefficient of brightness." It is used as follows:

> The horizontal illumination on a spot of pavement due to light from a specified direction is multiplied by the coefficient of brightness for the specified viewing *and incidence direction*. The product is the brightness of the pavement from the particular viewing direction.

The units of brightness are preferably expressed in foot-lamberts because the incident light is expressed in foot-candles.

The method by which the coefficient of brightness is derived is given in the paper.

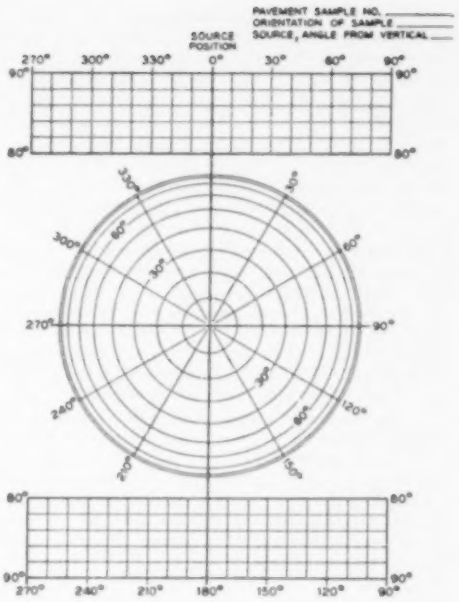
Methods of Charting. — Professor Kraehenbuehl has used one form of charting in Fig. 10 in his report, but states that he holds no brief for this particular form. In fact, he considers that such charting is beyond the scope of his contract. Instead, he considers that the decision about such charting, and the actual work of charting from his measurements, rest with those who will use the data.

In considering the many possible forms for charting the data, four objectives seem to be especially important. These are as follows:

(1) Consolidation of data. Does the method permit the plotting of the large amount of data for each pavement sample in a fairly concise form?

(2) Ease of visualization. Is the chart pictorial enough so that it can be understood with a minimum of study?

(3) Usefulness in plotting patterns of pavement brightness. Is the chart not too compressed to permit easy reading of values at typical angles of drivers' view?



A web for computing reflectances.

(4) Usefulness in calculating overall reflectance. Is the chart web chosen so that the reflectance of the pavement sample can be calculated without replotting?

More than a dozen possible forms of webs have been sketched. Of these, the web shown here is an example which appears to fulfill the four requirements above. One such web would show all the data for a given angle of incident light, and for each rotational position of pavement sample when surface configurations exist. Other web forms will be studied in the light of complete data when received.

Patterns of Pavement Brightness. — The first use of Professor Kraehenbuehl's data is expected to be in answering an important question now actively before the Committee on Street and Highway Lighting. This question is whether any revisions should be made in the relative values of illumination recommended in the American Standard Practice for light, medium, and dark pavements. Some revisions may be called for in view of the fact that Professor Kraehenbuehl's data will be far more comprehensive than anything formerly available on pavement reflection characteristics.

For this purpose we expect to compute patterns of pavements brightness for various pavement samples, as applied to representative street layouts. Preliminary discussions indicate that for such computations we might logically choose three layouts: a 30-foot pavement with one-side lighting, a 50-foot pavement with staggered lighting, and a 70-foot pavement with opposite lighting.

Steps in computation procedure are now under study by the Research Sub-Committee. The computations are lengthy

because patterns of pavement brightness differ for different viewing positions along and across a pavement. It is hoped that shortcuts can be found.

Angles of Cell Position. (a) *Vertical angles of cell.* — For studies of pavement brightness, the Research Sub-Committee can foresee no need of measurements with cell angles higher than those at which motorists and truck drivers view the pavement. That is, cell angles more than 10 degrees above the horizontal would have little or no significance in plotting patterns of pavement brightness. However, the Technical Advisory Committee on this research project and Professor Kraehenbuehl are in accord that it would not be wise to so limit the tests. The higher cell angles serve to complete the data — for more comprehensive studies of reflecting characteristics, for calculation of total reflectance, and perhaps for other uses not now anticipated. The vertical angles of cell position in Table I of the report reflect these considerations. To repeat, the cell angles above the horizontal in future tests will be 1, 2, 3, 5, 10, 20, 40, and 80 degrees.

For pavements *with* pronounced directional striations, cell positions in these two quadrants (on adjacent to and one opposite the light source) suffice when the striations are oriented at 0 or at 90 degrees with the direction of the incident light. By adding pavement orientations of 45 degrees and 135 degrees, cell positions in these same two quadrants afford intermediate values which we believe will be adequate for the purposes intended.

A. A. Anderson and James A. Foster*: Professor Kraehenbuehl has, in our opinion, developed excellent equipment for measuring the light reflecting values of pavement surfaces. Of major importance is the fact that curves for pavement samples can be taken rapidly.

We do not feel qualified to discuss the technical aspects of the equipment and procedures explained in the paper on "Pavement Surface Reflectance." However, we should like to discuss it from the viewpoint of highway engineers and outline the possibilities.

There are over three million miles of rural roads and some 320,000 miles of city streets. The hours of darkness are the most dangerous to pedestrians and motorists using these highways. From 7:00 p.m. to 7:00 a.m. rural roads carry only 26 per cent of the total daily traffic on them while the corresponding figure for city streets is 30 per cent. Yet these hours account for 52 per cent of the killed and 37 per cent of the injured. Any steps that can be taken to reduce such accident figures will be well worth while.

To our knowledge, very few states or cities have paid much attention to the determination of the light reflectance values of the many pavement surfaces and how this property could be tied into the problem of lighting and accident reduction. Oregon made such a study prior to World War II. It will be interesting to compare the results of the two methods.

Investigations in Massachusetts and Michigan have shown that it is cheaper to light a light-colored surface. There are no reliable figures available to show the relative frequency of accidents on light- and dark-colored surfaces. It is safe to assume that the lighter the surface the better it is for night driving.

Undoubtedly one of the reasons for the lack of research was that the investigations were time consuming and arduous. It appears that the method under discussion has overcome these handicaps and should lead to tests by more states and cities. They are all interested in obtaining roads and streets with better driving conditions both day and night.

In the case of rural roads it is financially, if not physically, impossible to artificially light at night all three million miles. The only light that can be used on 95 per cent or more of this mileage is that furnished by the car head lamps. Therefore, we must develop a road surface that is as safe as possible at night.

The data developed by the equipment of Professor Kraehenbuehl will give us the light reflecting values of our present road surfaces. We believe, also, that it will permit us to develop surfaces more suitable for night driving or airplane landing.

Concrete pavement can be finished in almost any way desired. At present it is broomed, dragged with burlap or belted to give it a non-skid surface, wet or dry. These methods of finishing can be varied to give optimum lighting qualities without sacrificing skid resistance.

Colors such as red or yellow can also be incorporated in the surface of concrete pavements. It may be that a combination of color and finished texture would be the answer to both lighting and skid resistance. In any event, the equipment in question can give the answer once the specimen has been prepared.

It is our understanding that it is also possible to make field checks on pavements in service with an adaptation of this equipment or of a type that field and laboratory results can be correlated. It is hoped that this correlation can be achieved as best results can be obtained when both field and laboratory investigations are followed and fully correlated.

John O. Kraehenbuehl*: It has been brought out in discussion that various methods may be used in presenting the data for analysis. Cartography, the science of collecting and analyzing data and measurements of the various patterns of the earth, has developed and established by mathematical analysis reliable methods which permit the representation of spherical data on a plane surface. The plots or charts give a clear and correct graphic expression of ideas.

When a spherical surface is projected on a plane surface it may take one of three forms:

1. Distortion in both area and angle,
2. Correct in angle but with distorted area,
3. Correct in area but distorted in angle.

Each of the methods for presenting data has some merit depending upon how the information and ideas are to be developed. The first and second attempt to give emphasis in specific regions while the third, which should be of the greatest interest to the illuminating engineer, permits of a study of data to a true solid angle because the area in any region is proportional to the solid angle.

Figure No. 10 in the text of the paper, represents the data drawn to the usual sinusoidal web used in street lighting for many years. To represent the complete globe requires two plots, one for each hemisphere. This presentation represents true areas with distorted angles. Solid angles, determined from the areas enclosed in conjunction with the average intensity in the angle, by calculation determines

*Highways and Municipal Bureau, Portland Cement Association.

*Author.

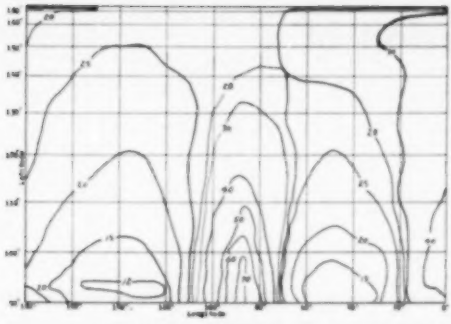


Figure 10a. Iso-brightness coefficient plot with source latitude (γ) 110°. Data plotted on an equal area cylindrical projection. New concrete wire-broom finish. Brightness coefficient in percentage.

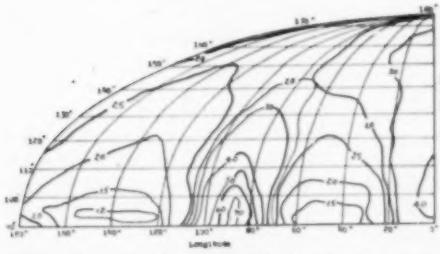


Figure 10b. Iso-brightness coefficient plot with a source latitude (γ) 110°. Data plotted on an equal area elliptical projection. New concrete wire-broom finish. Brightness coefficient in percentage.

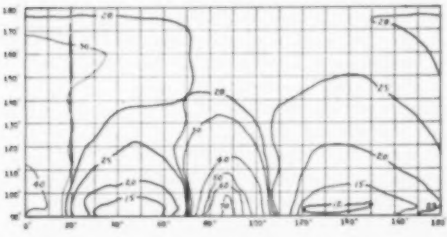


Figure 10c. Iso-brightness coefficient plot with latitude (γ) 110°. Data plotted to Cartesian coordinates. New concrete wire-broom finish. Brightness coefficient in percentage.

the lumens falling on the pavement surface enclosed by the solid angle.

Figure No. 10a and No. 10b are also equal area projections, the first in cylindrical projection and the second in elliptical projection. In both these instances a complete plot for the sphere requires one continuous representation giving a better coordination of the data. It is equally easy to determine the true solid angle from either plot. In the higher latitude values there is considerable crowding of the coefficient lines but this may be eliminated by enlarging the region, if that particular part merits special attention.

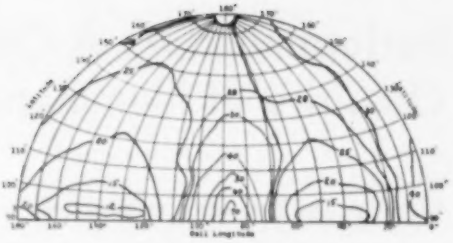


Figure 10d. Iso-brightness coefficient plot with source latitude (γ) 110°. Data plotted on a globular projection. New concrete wire-broom finish. Brightness coefficient in percentage.

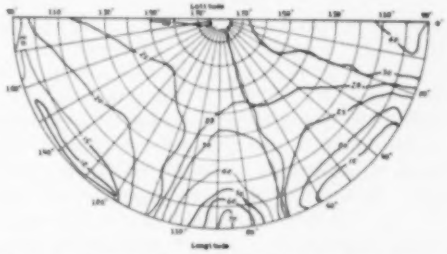


Figure 10e. Iso-brightness coefficient plot with source latitude (γ) 110°. Data plotted on an azimuthal equidistant polar projection. New concrete wire-broom finish. Brightness coefficient in percentage.

Figures No. 10c, No. 10d and No. 10e would be classified as picture projections from which values at various angles could be read but no interpretation as to solid angle would be possible. Figure No. 10c is a standard Cartesian plot and can be easily extended to the dimensions of the whole sphere in one drawing. Figures No. 10d and No. 10e are respectively a *globular* and a *polar* projection. In Figure No. 10d the emphasis is at the equator with crowding at the poles. This type would be useful in a study of angles close to the horizontal and satisfactory where pavement driving data was being recorded. In Figure No. 10e the emphasis is at the pole with crowding at the equator, a satisfactory plot for those interested in the higher angles, as in aviation.

Discussion has not seriously considered the implication of the type of data presented. The data are of a relative nature and do not embody absolute values of either intensity distribution or reflectance. All samples should be investigated under the same conditions as described in the paper for comparison purposes. In a final evaluation of the data it will be necessary to correlate the results with subjective data obtained with trained observers and drivers critical of the seeing conditions under which various types of surfaces are used, with different types of lighting and dryness.

The equipment for making the measurements has been developed for taking data in any portion of the hemisphere above the horizontal, therefore, the broader aspects of the use of pavement surface characteristics should be considered, not only for streets and highways but for aviation requirements as well.

Performance As A Criterion of Quantity of Illumination

With Special Reference to Weston's Data

Report No. 5 of the Committee on Standards of Quality and Quantity for Interior Illumination of the Illuminating Engineering Society*

FOREWORD

The following is a report of progress toward developing suitable basic criteria for determining the levels of illumination necessary for various visual tasks. It is the result of a four-year study and extensive discussions of the various methods of determining illumination recommendations.

In particular, this report is an appraisal of the application of Weston's performance data. It represents an approach to the problem: further treatment is expected as the Committee (comprising both practicing illuminating engineers and vision researchers) continues its studies.

COMMITTEE ON STANDARDS OF QUALITY AND QUANTITY

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1. Introduction

(a) The specification of quantity of illumination and quality of lighting should be based upon sound fundamentals. Seeing is an activity of human beings. Therefore, many different aspects of human behavior must be evaluated before it can be said that sufficient knowledge is available to permit the attainment of the final objective. In the meantime, it is possible to utilize existing data and techniques as guides for the establishment of tentative specifications. However, it must be emphasized that certain assumptions often are necessary in order to arrive at these specifications.

(b) The first effort of this Committee to apply experimental data to the specification of footcandle levels utilized the concept of supra-threshold visibility.[1] It appears desirable to investigate other approaches and to determine, if possible, the relationships among them. Therefore, as a second step, the Committee decided to examine some of the available data which included an evaluation of performance and the influence of level of illumination upon both speed and accuracy.

(c) When evaluating the lighting provided for a specific task, it is necessary to consider certain variables. The principal ones include:

(1) The nature of the visual task, including its size, reflectance, contrast, movement, etc.
(2) The quantity of light incident upon the visual task,
(3) The quality of the lighting, including distribution of brightness in the visual field, reflected glare, shadows, highlights, etc.,
(4) The spectral quality of the light,
(5) The state of adaptation of the eyes.

This report is concerned primarily with the problem of the quantity of illumination. To simplify the problem it is assumed first that the light sources emit only white light, and secondly that the sources have already been arranged to give the most suitable quality of lighting.

2. Illumination and Performance

(a) The utilitarian goal of a lighting system is to provide for optimal performance of a given task. The preliminary determination of the quantity of illumination required for objects which have to be seen with foveal vision can be based upon the relationship between illumination and performance. However, it cannot be emphasized too much that this is only a starting point. The final recommendation of quantity of illumination must take into consideration other factors such as the avoid-

*Approved by the I.E.S. Council, December 1950.

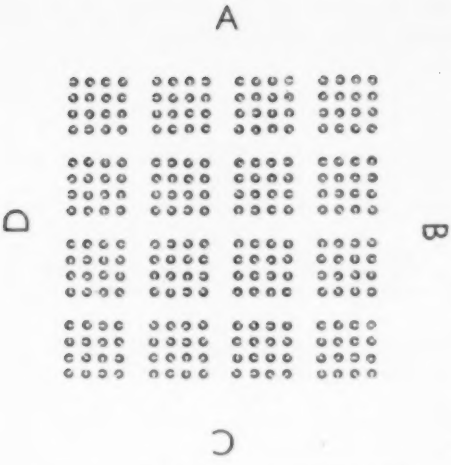

Figure 1. A typical work sheet used by Weston.

ance of fatigue, physiological and psychological costs not reflected in the evaluation of performance, the possible impairment of vision and health, and the cultural or emotional effects of light.

(b) Since the characteristics of visual tasks vary greatly, the ideal solution would involve complete experimental data for each test. However, this is not practical and, therefore, it is necessary to use such data as are available. A number of investigators[2, 3] have studied the relation of performance to the level of illumination, usually in terms of speed and accuracy. Of these, Weston's investigations[3] provide data covering a relatively wide range of task variables. It is of interest to note that these data which can be used as a guide for determining levels of illumination provide the basis for the British I.E.S. Code.[4] This report is an appraisal of the possible application of Weston's data to the specification of recommended illumination.

3. Weston's Performance Data

3.1—*Experimental Procedure*—Weston's investigations[3] included the effects of size and contrast as well as brightness upon speed and accuracy of work performance. Each subject in the experiment was presented with a specially prepared work sheet similar to the one shown in Fig. 1. The subject was required to cancel out all the Landolt broken rings having a given gap orientation. The subjects worked along each line of rings from left to right, as in reading or proof-correcting. The duration of each test was one minute, or the fraction of one minute as determined by the fastest worker. Each complete series of tests included variations of the size and contrast of the test objects and level of illumination. The visual angles subtended by the width of the gap in the Landolt ring ranged from 1 to 6 minutes. The contrasts used varied from 0.28 to 0.97 with a background reflectance between 38 and 90 per cent. The level of illumination included the range between 0.5 and 512 footcandles. Precautions were taken to minimize the effects of fatigue and the order of presentation of the test conditions. A special test was included to determine the "action time" involved in performing the physical task of canceling the rings. This latter value was utilized in the determination of the net ratings of visual performance.

3.2—*Assessment of Performance*—**(a)** The number of rings correctly canceled expressed as a fraction of the total number which should have been canceled (some were overlooked) is taken as the accuracy factor. The observed number of rings correctly canceled per minute is multiplied by the accuracy factor and results in a number which is an index of gross performance which takes into account both speed and accuracy. Subtracting the action time from this gross performance gives a numerical assessment of visual performance.

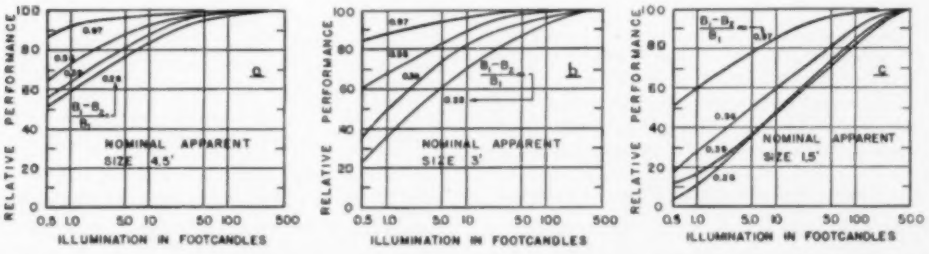

Figure 2. Relative performance as a function of level of illumination for three sizes of Landolt rings (Weston's data).[3]

(b) Relative performance is presented as the ratio of the actual performance at any contrast C or illumination E to the corresponding maximum performance attained with that size and contrast. Values of relative performance were determined for various sizes and reflectances of Landolt rings viewed against various background reflectances.

3.3—*Experimental Results*— (a) In one investigation[3] Weston kept the reflectance of the background constant at 0.9 and varied contrast C, size S and illumination E. For various values of C (0.97, 0.56, 0.39 and 0.28) and S (1.5, 3 and 4 minutes) Weston plotted the relative performance for six values of E (0.5, 2, 8, 32, 128 and 512 footcandles). The data are represented in Fig. 2. From these curves the footcandles E corresponding to the 85, 90, 95 and 98 per cent performance levels have been determined. The background brightness B (footlamberts) for each level of illumination E has been computed by

$$B = Er_1 \tag{1}$$

where r_1 is the reflectance of the background. In Fig. 3 are shown the relationships between contrast C and the background brightness B required for these performance levels.

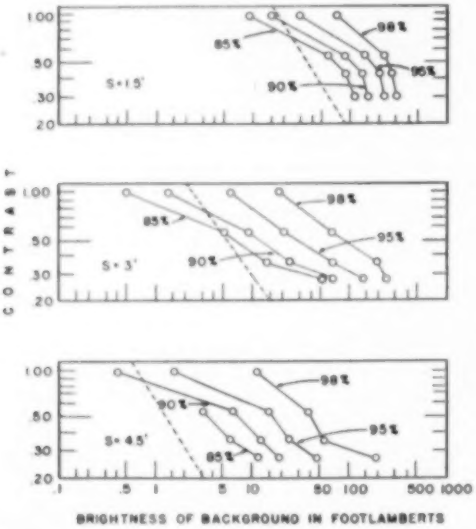

Figure 3. A replot of Weston's data (Fig. 2) showing the relationship between contrast and brightness of background for four levels of performance.

(b) Weston developed the following general empirical formula from his results:

$$E_w = \frac{K}{S^n (r_1 - r_2)} \tag{2}$$

where E_w = working illumination for any level of performance, w

K and n = constants

S = size of critical detail in minutes

$r_1 - r_2$ = difference between reflectances of background and details of visual task.

From the relationship between illumination and brightness, Equation 1, and inserting the appropriate values of K and n, Weston's equation may be transformed into the following for the 90 per cent level of performance:

$$B_{90} = \frac{56}{S^3 C} \tag{3}$$

Assuming that a level of performance of about 90 per cent constitutes a desirable objective, Weston has recommended the use of this equation for prescribing illumination, and it has been used as the basis for the British I.E.S. code.[4] The broken lines in Fig. 3 represent values of brightness for various contrasts as determined by this equation. It is evident that these equations hold only for a contrast approaching 100 per cent, and for lower contrasts yield values of brightness (or illumination) increasingly lower than indicated by the actual data. The levels of illumination indicated by Weston's equation for 90 per cent performance are lower than the standards adopted for current recommended lighting practice in the United States which correspond to a level of performance between 90 and 100 per cent.

(c) While Weston's data (Fig. 3) pertain only to a specific visual task, it is assumed that they can be applied to others by measuring certain physical characteristics of the tasks. The procedure is to select and measure some dimension of the object as being the size S of the critical detail which corresponds to the width of the gap in the Landolt ring. It is necessary also to measure separately the reflectances of two adjoining surfaces which correspond to the Landolt C and its background.

(d) A size gauge which has a series of lines of various widths and a reflectance gauge which has a series of gray surfaces of different reflectances are available to determine the size of the critical detail and the reflectances by direct comparison. The

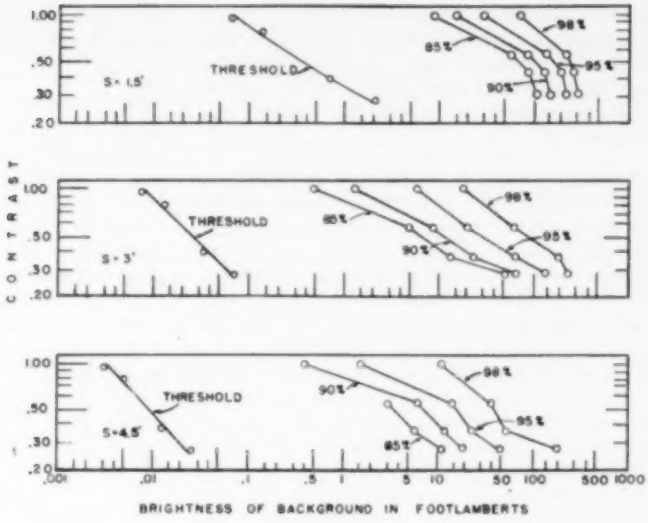

Figure 4. The relationship between Weston's performance data[3] and the Connor-Ganoung threshold data[7] for three sizes of Landolt rings.

value of illumination E required for a desired level of Weston's "performance" can then be determined from the data of Fig. 3 (the data do not warrant extrapolation). Size and reflectance gauges have been incorporated in a device designed by Logan[5] called an Illumination Levels Indicator.* The Munsell Reflectance Scales[6] are also available for determining reflectances.

4. Relationship Between Performance and Threshold Data**

(a) The relationship between Weston's data for several levels of performance and the Connor-Ganoung[4a, 7] threshold data is presented in Fig. 4. Both sets of data are for the Landolt ring test object. The threshold curves each are for a specific size of test object but having various contrasts. The threshold is in terms of the illumination level which is just sufficient for the position of the gap in the Landolt ring to be discerned correctly in 56 per cent of the observations made for eight positions of the gap. In general, for high visual performance, seeing must be made relatively easy. Hence, considerably more light is needed than that required just to bring the object to threshold.

(b) Within the range for which the threshold curve of brightness *versus* contrast may be regarded as parellel to Weston's performance curves, it is possible to substitute threshold measurements for Weston's analysis and measurement of the critical size and the contrast of a visual task.

(c) Although sufficient data are not yet available to indicate the range of validity of this method, it offers some promise of providing an improved technique. Threshold measuring instruments such as the Luckiesh-Moss Visibility Meter[8] reduce, for the observer, either the brightness or contrast (or both) to threshold value. Having measured the threshold of the task one should simply apply the predetermined factor necessary to raise the brightness and illumination from threshold to the desired standard or level of "performance."

5. Limitations to the Application of Weston's Data*

(a) It should be pointed out that Weston's experiments involved a very limited number of visual skills. Such skills as detecting brightness and color differences for objects which are completely separated from each other, judgment of relative size, distance, direction and movement are all affected by quantity of illumination, but are not included

*Logan's original disc indicator is based upon Weston's equation.

**Weston previously related performance data to Lythgoe's threshold data in a paper entitled "Illumination and Industrial Efficiency." *Trans. of the Ophthalmological Society*, London, 1943, Vol. LXIII, p. 348.

*For Weston's discussions of the limitations of the application of his data see Reference 4a and *Sight, Light and Efficiency*, H. K. Lewis & Co., Ltd., London, 1949.

in Weston's data. It may well be that a recommendation of quantity of illumination based upon Weston's performance data will be adequate also for the use of these other visual skills, but further investigation is needed to determine whether this is true.

(b) Weston's data are based on an evaluation of performance which may not apply to other specific tasks for which illumination is being provided. In certain situations the speed of output is fixed and accuracy only is affected by level of illumination. In other situations, the task is so simple that each unit turned out requires no further inspection, and speed is the important factor. In still other situations, performance may be evaluated on an entirely different basis. In an inspection operation the percentage of defective items detected may be the all-important consideration. If the defects vary in size and contrast, the percentage of defective items detected will depend upon the ability of the eye to detect low contrast and small detail, which may not be within Weston's range (see paragraph "d"). In such a situation threshold data[9] may be used to predict whether defects of the smallest size or lowest contrast will be detected.

(c) Weston has not indicated the scatter of the data used in computing the average performance value for a given combination of *G*, *B* and *S* values. Therefore one cannot tell from Fig. 2 to what extent the level of illumination must be changed in order to produce a statistically significant change in level of performance.*

(d) Weston's data are limited to contrast value between 0.97 and 0.28 and to visual angles from about one to six minutes. Therefore, the validity of extrapolating Weston's equation to lower contrasts and to other sizes for prescribing illumination is doubtful.

(e) In some cases a rigorous application of Weston's equation would lead to the recommendation of levels of illumination lower than two footcandles. Levels lower than this are generally avoided because they make the worker feel gloomy or depressed in spite of the fact that under these conditions crude tasks can be performed with a high level of visual efficiency.

(f) Certain types of visual tasks defy analysis in terms of contrast and size of critical detail. In such cases it is difficult and sometimes impossible to apply Weston's method.

(g) Even when critical detail does exist there often is danger of error in identifying it. Commonly the gap in a lower case "e" is the critical detail assumed where "e" appears in a word. But the task is only to distinguish "e" from the other letters of our alphabet, probably only from the other vowels, and certainly not from all other conceivable hieroglyphics. Because the only similar printed letters are "c" and "o" it is clear that the bar which distinguishes "e" from "c" or, if the gap is indistinct, from "o," is the critical item. Possibly this is an easier task than discerning the gap, so that using the gap as the size of critical detail might not be correct. It might be better to use the critical detail of the bar.

(h) Originally Weston used subjects of an average age of 35 years with normal or corrected-to-normal vision in a relatively ideal environment. A more recent investigation[10] included performance data by subjects of various ages ranging from approximately 20 to 50 years. The results indicated that performance decreased with age and that considerably higher levels of illumination were required by the older workers in order to attain optimum levels of performance. Similarly, it would be expected that higher levels of illumination would be required for those possessing defective vision.

6. Summary

(a) A study of Weston's data indicates that it can be used as one of the guides for determining illumination in terms of his defined "performance." The method appears to be useful in those situations where the size and contrast of the task and the reflectance of the background can be measured and where they are within the range of Weston's data.

(b) A comparison of Weston's data with threshold data demonstrates that at least for some conditions the different levels of Weston "performance" bear a definite relationship to the threshold. This provides the basis for another technique in appraising and prescribing illumination.

(c) While Weston's method has certain inherent limitations, it appears that if its application is tempered with sound judgment, it is a useful tool for illuminating engineers.

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*"Communication from Weston, June 4, 1951: " . . . the scatter of individual performances about the mean varies with illumination, but when the illumination is sufficient for an average relative performance of not less than about 90 per cent the scatter appears to fall to an irreducible minimum."

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4a. Weston, H. C., "Proposals for a New Lighting Code," *Trans. I.E.S.*, London, February 1943.

4b. "I.E.S. Code of Practice for Good Lighting of Building Interiors including Recommended Values of Illumination," Illuminating Engineering Society, London, 1945.

5. Logan, H. L., "Supplementary Instructions in Connection with the Use of the Illumination Levels Indicator," Holophane Co., New York.

6. Macbeth, N., "Munsell Value Scales for Judging Reflectance," ILLUMINATING ENGINEERING, February 1949.

7. Connor, J. P. and Ganoung, R. E., "Experimental Determination of the Visual Thresholds at Low Values of Illumination," *J. Opt. Soc. Am.*, September 1935.

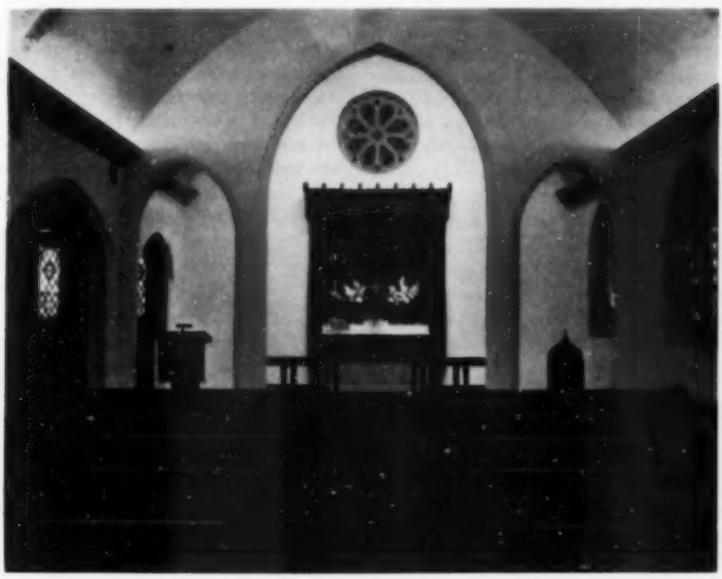
8. Luckiesh, M., Guth, S. K., and Eastman, A. A., "A New Scale of Relative Footcandles," ILLUMINATING ENGINEERING, April 1950.

9. Moon, P. and Spencer, D. E., "Visual Data Applied to Lighting Design," *J. Opt. Soc. Am.*, October 1944. Blackwell, H. R., "Contrast Thresholds of the Human Eye," *J. Opt. Soc. Am.*, November 1946.

10. Weston, H. C., "Age and Illumination in Relation to Visual Performance," *Trans. I.E.S.*, London, September 1949.

Fluorescent Lighting in a Small Chapel

Fluorescent cove lighting technique has been used to enhance the beauty and simplicity of this small chapel, Mt. Olivet Lutheran Church, Minneapolis, Minn. Continuous rows of fluorescent lamps in the side coves are supplemented by six incandescent lamps in ribbed glass reflectors evenly spaced inside the arch, 150- or 200-watt, where the arch meets the ceiling; and a row of 40-watt T-10 luminline lamps back of the carved valance which lights the velvet drapery behind the Altar. ***Photograph and data courtesy of the General Electric Co., Nela Park, Cleveland, Ohio.***



Questions and Answers on light sources

The I.E.S. Committee on Light Sources, under the chairmanship of E. H. Raddin, has prepared this listing of answers to frequently-asked questions. Readers are invited by the Committee to submit similar questions of general interest on light sources, to be considered for publication from time to time. Questions may be sent in care of Society Headquarters.

What is the usual operating current of cold cathode fluorescent lamps?

Cold cathode lamps are usually rated at 120 milliamperes. The type HP lamp can be operated at currents up to 200 ma, while the type LP can be operated at currents up to 150 ma. Operation at the higher currents causes a reduction in lamp life.

What is the difference between hot and cold cathode fluorescent lamps?

[*The following answer to this question is quoted from pages 8-41 to 8-42 of the* I.E.S. Lighting Handbook, *2nd Edition.*]

"Fluorescent lamps generally are divided into two classes, according to the type of cathode (electrode) used. These are: (1) Hot (filamentary) cathode lamps and (2) Cold (cylindrical) cathode lamps.

The hot cathode lamps contain electrodes which usually are coiled coil tungsten filaments coated with one or more of the alkaline earth oxides. By suitable circuit arrangements these cathodes can be heated to a good electron emitting temperature before the arc is struck or they may be required to act momentarily as cold cathodes until heated by bombardment after the lamp is started. Lamps using these cathodes may be designed to carry rather heavy currents (1 to 2 amperes) with low voltage drop (18 volts) at the electrodes. Unless the electrodes are kept at the proper temperature by means of an external heating circuit they do not withstand frequent starting without correspondingly shorter life.

The cold-cathode lamps use electrodes of cylindrical form which may be coated on their inside surfaces with electron emitting materials. These cathodes operate at temperatures below that necessary for satisfactory thermionic emission and therefore the lamps are limited to low current densities. The electrode drop in these lamps is relatively high (105 volts), but they are not subject to short life as a result of frequent instant starting.

The only differences in the behavior of the two types of lamps are those imposed by the cathode characteristics outlined above. Otherwise their lumen output and lumen maintenance are the same for the same bulb size, phosphor, and conditions of loading in amperes per unit area of phosphor surface."

What are some of the factors that determine the size and shape of a glass bulb to be used for an incandescent filament lamp?

The size and shape of a glass bulb for an incandescent filament lamp are determined by factors such as lamp wattage, application requirements, and economics of lamp manufacture. If too small a bulb is used relative to the lamp wattage, poor lamp performance including possible violent failure may result. Application requirements include space limitations of equipment in which the lamp is to be used, type of light distribution desired from the lamp, and whether the lamp is intended for decorative or other special purpose applications. The bulb design must be such that a high quality bulb can be economically produced and applied in modern lamp-making processes.

Can I shoot color film with ordinary general service incandescent filament lamps?

While ordinary general service incandescent filament lamps can be used for black and white photography, color photography requires use of lamps designed to produce light of a specific color temperature, in order to match the spectral response of the film emulsion. For example, photoflood lamps operating at approximately 3400K match the emulsion characteristics of indoor type color film. Other types of color film may require lamps of a different color temperature.[1]

1. Table 8-24, *IES Lighting Handbook*, 2nd Edition.

TELECAST

LIGHTING NEWS OF CURRENT INTEREST

South Pacific Coast Leads Off 1952 I.E.S. Regional Conferences

First of this year's I.E.S. Regional Conferences was held March 13-14 at the Sir Francis Drake Hotel in San Francisco. Northern California Section was host, with all of the Region's Sections and Chapters participating. More than 200 I.E.S. members and guests attended the meeting.

As is usual with west coast conferences, the meeting offered features comparable to a national convention, including high quality technical sessions and an especially enjoyable social program.

I.E.S. President S. G. Hibben was guest of honor at the dinner-dance which concluded the conference March 14. Mr. Hibben opened the conference with a review of the growth of lighting, and was also speaker at a joint meeting of the Northern California Section and the San Francisco Electric Club on March 10, with a press conference preceding.

Technical Program

Recent developments in filament lamps and electric discharge lamps, respectively, were reported by Charles R. Long, Pacific Coast district engineer of Westinghouse Electric Corp., and D. W. Prideaux, of the General Electric lamp division, both of Los Angeles. Mr. Prideaux emphasized the rapid advance in the discharge field by pointing out that of the 24 lamps he reviewed, three had come out in the last few months and one of those so recently that he had not had opportunity to obtain its characteristics.

William P. Lowell, Jr., manager of commercial engineering, Sylvania Electric Products Inc., Salem, Mass., reviewed research into electro-photoluminescence and demonstrated examples in several colors, suggesting possible applications.

The first phase of the program, dealing with light sources and circuits, continued with "Fluorescent Lamp Performance on Series Ballasts" by E. E. Coleman, district engineer, General Electric lamp division, Los Angeles; "Use of 480-277Y Connected System for Copper and Cost Savings in Industrial Lighting" in which Harold L. Gerber, San Francisco engineer, reported possible copper savings of 25 per cent; and "Ultra High Intensity Radiation Sources and Instrumentation" by Ted Broida of the U. S. Navy radiological defense laboratory, San Francisco.

The Friday sessions were concerned with applications, with emphasis on industry and defense production.

William F. Jones, a consulting engineer, presented a well-received review of the research on glare by Sylvester K. Guth, comparing his results with those of others in the field. The growing trend toward completely integrated ceilings in new construction was discussed by H. L. Wollman, consulting engineer, who reviewed the various "packaged" ceiling units for lighting, air conditioning acoustical treatment, ventilation and insulation. George J. Taylor, eastern sales manager of Day-Brite Lighting Inc., strongly urged greater attention to brightness engineering, discussing "Virtues of Seeing Comfort in Office Lighting."

The importance to industry of more exact color measurement specifications and control was stressed by Dr. L. H. Brown, acting head of the Stanford University department of electrical engineering. He cited difficulties of matching roofing shingles, grading of fruit by color, and even obtaining identical paint samples as typical problems. Robert Ryan, Visalia, California, gave an example with a discussion of grading belt lighting.

Menno N. Harder of the State of California Division of Architecture showed slides of the lighting of California's new Capitol Annex building in Sacramento. Marcel Vogel of San Francisco, a leader in the practical application of filtered longwave ultraviolet "black light," reviewed three fields of

REGIONAL Vice-President Carl O. Martin chats (left) with President S. G. Hibben and H. H. Robison, general chairman of the South Pacific Coast Regional Conference. (Right) B. H. Hartley, chairman of the newly-formed Arizona Chapter and S. H. Simonsen, chairman of the Southern California Section get together for a talk.

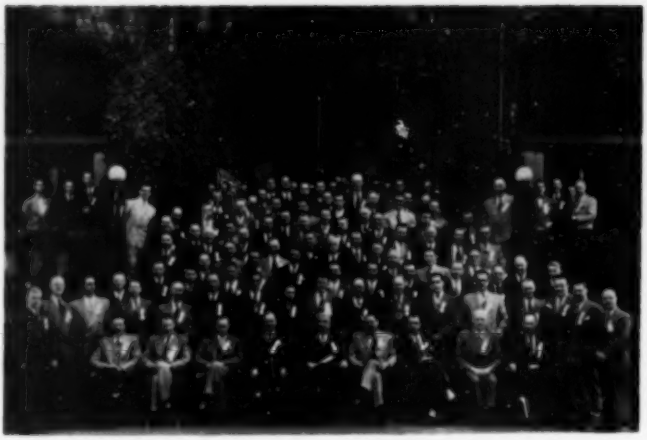
analytical use in industry, detecting animal traces, detecting fluorescence after intravenous injection for medical diagnosis, and detection of surface defects in metals.

A prediction that fluorescent street lighting will gain in America was made by W. C. Brown, manager of engineering of the General Electric Co., Nela Park. He cited outstanding results obtained in Great Britain, which is far ahead of the United States in this application.

CREDITS

Chairmen of the five Sections and Chapters comprising the South Pacific Coast Region, each presided at a session of the technical program. S. M. Blacksmith, Chairman of the Northern California Section had the opening session, March 13. The afternoon session was in charge of S. H. Simonsen, Chairman of the Southern California Section; L. E. Barnum, Chairman of Mother Lode Chapter had the evening session. On March 14, the morning session was in charge of B. H. Hartley, Chairman of the Arizona Chapter; with Wayne Shaw of Utah Chapter, heading the afternoon meeting.

The successful conference was planned and conducted under the direction of H. H. Robison as Conference Chairman, assisted by S. H. Hazleton, Papers; Matt A. Cabot, Reception; W. R. Major, Membership; J. S. Walsh, Attendance; C. T. Bakeman, Entertainment; C. W. Macy, Hotel; Ward Shafer, Finance; R. L. Sawyier, Publications; Harry McMasters, Publicity.



DELEGATES to the Pacific Northwest Regional Conference on the steps of the ivy-covered Empress Hotel in Victoria, B. C. Approximately 200 attended the two-day conference.

Pacific Northwest Conference Features Salute to Lighting Progress

Over 200 delegates and guests were present to enjoy the full two-day program of the Pacific Northwest Regional Conference held at the famed ivy-covered Empress Hotel in Victoria, B. C., March 20-21. Close cooperation between Vancouver, the home of the British Columbia Section, host to the Conference, and I.E.S. members in Victoria resulted in the interesting and enjoyable program of technical sessions and entertainment. Theme of the meetings was "Salute to Lighting Progress."

The Hon. Claude L. Harrison, mayor of Victoria welcomed the delegates and made the opening address of the first morning meeting. The four sessions were presented as follows:

MORNING — MARCH 20

H. J. Ashbee, Chairman, British Columbia Section, presiding.
Opening Ceremonies—Hon. Claude L. Harrison.
"A Revolution in Industrial Lighting Practice"—Willard C. Brown, General Electric Co.

AFTERNOON — MARCH 20

F. C. Schatz, Chairman, Puget Sound Section, presiding.
"The Trend in Modern Fluorescent Ballast Design"—W. P. Lowell, Sylvania Electric Products Inc.
"Standardization of Fixture Design"—Beverly A. Travis, Consulting Engineer, Seattle, Wash.

MORNING — MARCH 21

E. R. Fletcher, Chairman, Oregon Section, presiding.
"Importance of Comfort for Office Lighting"—George J. Taylor, Day-Brite Lighting Inc.
"School Lighting in Eastern Canada"—John M. Charlton, Toronto Board of Education.
Luncheon with Victoria Electric Club at the Crystal Gardens—Guest speaker, Willard C. Brown, "Lighting in Europe."

AFTERNOON — MARCH 21

D. G. Parker, Chairman, Inland Empire Chapter, presiding.
"A New Concept in Home Lighting"—Dorothy McGregor, British Columbia Electric Rly. Co. Ltd.
"Street Lighting, a Science"—E. B. Karns, Westinghouse Electric Corp.
Closing Remarks.

NATIVE Indian sweater, made by the Koksilah Tribe, and presented to Mr. Hibben by the British Columbia Section, is tried for size by the President while (from l. to r.) Mrs. H. J. Ashbee, P. A. Donnelly, E. W. Thompson, P. F. Fletcher and H. J. Ashbee admire the result.

The President's Reception and Banquet, held in the Crystal Ballroom the evening of the first day, scored a big success. Mr. Hibben was presented with a native Indian sweater, knitted by the local Indians of the Koksilah Tribe from a mixture of unprocessed sheep's wool and goat hair. Alston Rogers presented one of his ever-popular demonstrations of new developments in lighting equipment, a down-to-earth and entertaining review of lighting progress.

Other entertainment for guests of the delegates was a tour of the beautiful capital city — located on the 282-mile long Vancouver Island — and a tea at the Oak Bay Beach Hotel.

Credit for the fine program and the skilful manner in which it was conducted goes to the hard-working Co-Chairmen, P. A. Donnelly and E. W. Thompson of Vancouver and P. F. Fletcher of Victoria, and to the Conference Committee and Committee Chairmen.

Conference Committee

P. A. Donnelly, Co-Chairman
E. W. Thompson, Co-Chairman
P. F. Fletcher, Co-Chairman

E. Jarvis	E. E. Ackland
W. J. Lind	H. J. Ashbee
R. G. Scott	T. H. Doherty

Committee Chairmen

Finance — E. E. Ackland
Papers — W. J. Lind
Extension — H. N. Walters
Publicity & Printing — B. Manlove and P. S. Fletcher
Reservations & Registration — M. Murphy
Banquet & Luncheon — G. Langdon
Entertainment — K. Reid
Ladies' Entertainment — Mrs. K. Reid
Properties — A. Evans

The choice of Victoria as the "Conference City" has done much to develop local interest in the I.E.S. and to give added impetus to the efforts of a formative group, under Ken Reid, Chairman, which is working with the help of the Vancouver Section toward the organization of a Victoria Chapter.

What to See In Cleveland

When you are in Cleveland, either for the I.L.E. or on a routine trip, you will be interested in visiting the many lighting installations in town. For a list of these installations, see page 24A, this issue.

New Oklahoma Chapter Host to Southwestern Regional Conference

In reporting on their Southwestern Regional Conference held in Tulsa April 6 through 8, the conference leaders said, "Even Texas was impressed!" It's no wonder. They staged a three-day affair that was the talk of the town—literally, judging from the newspaper coverage, both pictorially and in column inches.

The technical program was an especially fine one. Some 250 lighting people from eleven states had an opportunity to meet and discuss their favorite subject (illumination, of course). The entertainment was of convention scale, and particularly well planned and handled.

A change of pace from the technical sessions was afforded by several side meetings, including a joint luncheon Monday with the Engineers Club of Tulsa, at which I.E.S. President Hibben was guest speaker; a Regional V P business meeting Sunday afternoon; a joint luncheon for both delegates and ladies, with an inspirational talk by John Frank on "Art for Living."

A highlight of the luncheon meeting, Tuesday, was the formal presentation of the Oklahoma Chapter's Charter. President Hibben made the presentation to R. G. Smith, Chairman of the new group.

Ladies' Program

Wives of the conference delegates were entertained with a planned program of tours, luncheons and dinners. Mrs. Dale H. Watt entertained at her home for 40 visitors at a morning mixer opening day, to get acquainted before the luncheon meeting at the After Five Room of Hotel Tulsa. Mrs. Robert G. Smith and Mrs. M. J. Myers planned the programs.

Pia Coopta

I.E.S. President S. G. Hibben is now an honorary member of the Comanche Indian Tribe. During ceremonies conducted by Charles Chibitty, Comanche Indian, at the dinner dance Monday evening, he was initiated as a blood brother. He was named Pia Coopta, meaning Big Light, and presented with an Indian headdress.

Technical Program

As pleasant as the social program was, the three full days of technical sessions were the high points of the conference. Outstanding speakers presented subjects of important current interest which, for the record were:

April 7. Chairman, J. T. Meletio

This Conference, by W. E. Folsom, Regional Vice-President.
Welcome Address, by C. N. Robinson, Vice-President, Public Service Company of Oklahoma.
Report of the Regional Vice-President, by W. E. Folsom.
Your Society in '52, by S. G. Hibben, President of I.E.S.

(Continued on page 10A)

JOINT luncheon meeting with the Engineers Club of Tulsa, sponsored by the Southwestern Regional Conference, April 6-8 in Tulsa, Okla.

Since the introduction of fluorescent lighting...

greatest STEP UPWARD in industrial SEEING COMFORT

...new BENJAMIN "Task Master"

Shatters precedent with a completely new concept of lighting unit design!

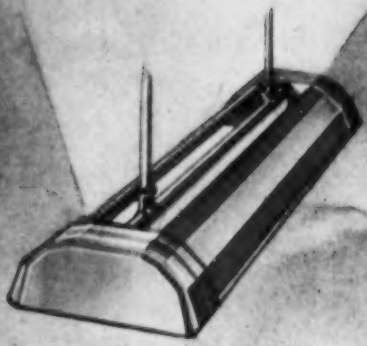
Masters the brightness ratio problem by directing approx. ¼ of light upward!

Doubles... even triples... present standards for industrial seeing comfort!

Introduces new methods of installation and maintenance!

Yes, the new Benjamin "Task Master" is the greatest step UPWARD in industrial fluorescent lighting history. It's a step UPWARD to high lighting levels without the discomfort which can often accompany them... a step UPWARD to complete freedom from annoying ceiling contrast that may cause excessive brightness ratios. It's a step UPWARD to greater seeing comfort in America's work places! Moreover—"Task Master" represents a great step UPWARD in high-speed installation and trouble-free maintenance, as shown above. Get full details about this greatest step UPWARD in industrial seeing comfort... send for FREE "TASK MASTER" Data Bulletin, containing complete specifications. Write:

Benjamin Electric Mfg. Co., Dept. I, Des Plaines, Ill.



3 ways to mount: chain, conduit and sliding hanger suspension (illustrated).

UPWARD ILLUMINATION COMPONENT directs approximately ⅓ of light towards the ceiling. In addition to providing more generous **UPWARD** flow of light, this unique construction reduces maintenance expense as it practically eliminates horizontal areas where dust and dirt can collect.

DETACHABLE REFLECTORS are hinged to facilitate easier, more thorough cleaning right on the fixture; or they may be quickly unhinged and replaced with reflectors which were previously cleaned at a bench. 2 simple spring-type clips lock or release each reflector . . . no tools needed.

PRE-WIRED . . NO WIRE SPLICING . . All Connections made to Terminal block. No need to run line wire through fixture. Furnished with branch circuit wiring already run through a combination spine support and lamp shield. (Shielding angle is 35°) Just connect line wires to terminals (see picture A above). For continuous line installations, simply connect "jumper" wires to opposite terminal blocks (see picture B).

BALLAST AND TERMINAL BLOCK are strategically located in easily-accessible end sections . . . out of the way for more streamlined appearance.

Of course, **EXCLUSIVE BENJAMIN "SPRINGLOX" LAMPHOLDERS** are standard equipment. They are acknowledged as embodying the most advanced lampholder features. Such as: rugged, all-metal construction and unique, patented spring design for "quick-in, quick-out" lamp maintenance.

BIG LIGHT. S. G. Hibben, I.E.S. President, was made honorary blood brother of the Comanche Tribe by Charles Chibitty at the dinner dance of the Southwestern Regional Conference. He was named Pia Coopta, which means Big Light.

SOUTHWESTERN Regional Conference planners are, left to right front row, Oscar F. Shaw, Robert G. Smith, Charles Baum; back row Dale H. Watt, M. J. Myers, general chairman, and A. N. deEspensa. How well they accomplished their planning is evidenced by the enthusiastic response — "even Texas was impressed!"

(Continued from page 7A)

Analyzing Lighting Costs, by E. A. Linsday, General Electric Co., Lamp Division, Cleveland, Ohio.
Grid Systems, by Eric H. Church, Benjamin Electric Mfg. Co., Des Plaines, Ill.
Color Is How You Light It, by T. C. Sargent, Sylvania Electric Products Inc., Salem, Mass.
Vapor Light Sources, by E. W. Beggs, Westinghouse Electric Corp., Bloomfield, N. J.

April 8, Chairman, R. G. Smith

The Contractor and the I.E.S., by Les Allen, Allen Electric Co., Tulsa, Okla.
Industrial Lighting and Infrared Application, by E. A. Linsday, General Electric Co.
The Architect and Lighting, by Donald McCormick, Architect.

Afternoon Session

Chairman, H. G. Hrivnatz

Lighting in the Southwest, by H. G. Hrivnatz.
Planned Lighting in the Southwest, presented by:
Ed. Barry, Arkansas Power & Light Co., Little Rock.
A. L. Lacy, Central Power & Light, Corpus Christi.
E. A. Honsberger, Gulf States Utilities, Beaumont.
James D. Hampton, Oklahoma Gas & Electric Co., Oklahoma City.
Floyd Covington, City Public Service Bd., San Antonio.
S. K. Lathrop, Southwestern Gas & Electric, Shreveport.
Andy Anderson, Texas Electric Service, Ft. Worth.
John Dock, Texas Power & Light, Dallas.
Tom Lynn, Southwestern Public Service Co., Amarillo.
A. A. Stettz, Dallas Power & Light, Dallas.
L. J. Carlon, Albert Sechrist Mfg. Co., Denver.

The success of the conference was by no means happenstance. Careful planning and work were done by many local members from the Several Sections and Chapters participating, and especially the host group, Oklahoma Chapter. Credit for this is due to the following committees:

M. J. Myers, General Conference Chairman.

Finance Committee: Dale H. Watt, C. B. Smith, Arthur F. Weers, E. C. Ober and W. T. Kimery.

Papers and Program Committee: B. F. Benning, R. G. Smith, H. G. Hrivnatz, B. L. Guess, Jr., and Floyd A. Covington.

Entertainment Committee: T. C. Weir, Harold F. Miller, and Charles Baum.

Reservation Committee: Hiram West.

Transportation Committee: Harold F. Miller and Oscar F. Shaw.

Ladies Reception Committee: Mrs. R. G. Smith and Mrs. M. J. Myers.

Michigan Section Reunion Dinner Held

The contest-night meeting for Michigan Section's "My Most Interesting Lighting Job" was the occasion April 8 for a reunion dinner honoring 22 living past-chairmen of the Section. Many of them were from great distances, such as George Bogard who came from Schenectady; Ivar Stockel from Chicago; Jim Ketch from Cleveland; Charles Conklin from Pittsburgh, and Art Crawley from Flint. Past President Lee Tayler is a past chairman of the Section, and was present. Jim Ketch did a grand job as toastmaster at dinner and introduced all of the past chairmen in his talk.

The dinner was also attended by Vice-President Fred Compton of the Detroit Edison Co., and the manager of sales,

(Continued on page 13A)

I.E.S. National Technical Conferences

September 8-13, 1952—Edgewater Beach Hotel, Chicago, Ill.

Week of September 14, 1953—Hotel Commodore, New York, N. Y.

Week of September 12, 1954—Chalfont-Haddon Hall, Atlantic City, N. J.

New G-E mercury lamp stays bright without cleaning!

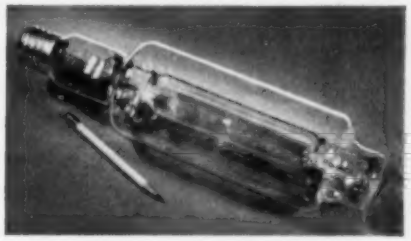
G-E produces first mercury lamp with built-in reflector

General Electric's new 400-watt mercury lamp for general lighting needs no cleaning or maintenance throughout its life under ordinary use. The first reflector mercury lamp ever made available, the G-E H400-R1 is designed for foundries, welding shops and other plant areas where collection of dirt on fixtures severly cuts light output and high mounting makes cleaning difficult.

Because the reflector is built-in, dust collecting on the sides of the lamp can't reduce light output. The highly efficient reflecting surface controls the diffusion of light, directs it downward through the bottom of the bulb where little or no dust collects. The new H400-R1, shown at left, generates light of the regular mercury color.

New reflector lamp also available in color improved type

The new built-in reflector mercury lamp above is also available in a special color-improved type, the H400-RC1, for plant areas that require lighting with good color rendition. It has all the advantages of the lamp shown above, yet gives better color than regular mercury lamps. A novel application of phosphor to the inside of the bulb produces approximately the same color as a mixture of ⅓ filament light and ⅔ mercury light. This new lamp is available in 400 watts. The H400-R1 and H400-RC1 lamps have a life rating of 3,000 hours at five hours per burning start, and 4,000 at 10 hours per start. Both have mogul screw bases.



1000-watt lamp added to regular G-E mercury line

This new G-E lamp fills the gap between the 400-watt and 3000-watt lamps in the regular G-E mercury line. Producing 52 lumens per watt, it is the most efficient of the mercury lamps used for general lighting. Particularly suited for high mounting in industrial areas where low cost of light is desired.

You can put your confidence in —

GENERAL ELECTRIC

For visual signals, for controlled distribution of light, for colored floodlighting effects, for intense concentration of light in beams or for uniform coverage of limited areas, Kopp lenses, color filters or roundels give the control and modification desired. Whether it be a traffic signal lens designed to concentrate the beam in the area where it is most easily perceived by motorists, or an indicator light to warn a housewife that one of her appliances is in operation —Kopp engineers can develop the most effective design, and Kopp craftsmen produce parts that are accurately made and dependably uniform in color, dimensions and transmission value.

Our well-staffed, modernly-equipped laboratory is prepared to study your requirements and develop designs that will meet your most exacting specifications.

KOPP GLASS

KOPP GLASS, Inc.
SWISSVALE, PA.

(Continued from page 10A)

E. O. George. I.E.S. Regional V-P Fred Winkler was in from Cleveland, Paul Cornelisen of Curtis came over from Chicago, and Hayden Carney came up from Toledo; also Dan Dunn of Lighting Products was in from Highland Park, Illinois.

One hundred and fifty people sat down to dinner in the Colonial Room of the Detroit Leland Hotel, following a cocktail hour. It was a memorable evening for Michigan Section members.

I.E.S. Lighting Club Organized in Greenville, S. C.

Local I.E.S. members in Greenville, South Carolina have established a Lighting Club there, under the sponsorship of their parent Chapter, Carolinas, to meet for luncheon once a month. The project promises considerable success as an I.E.S. group, and an opportunity to widen the scope of the Chapter's services to its outlying members, as well as a chance for local members to meet and discuss subjects of common interest.

Twelve local members attended the organization meeting on February 4 and elected officers to direct the Club's affairs. J. W. Lewis, Duke Power Co., was elected Chairman; L. W. Burdette, of J. E. Sirrene & Co. is Vice-Chairman; Glenn Rice, Huntington and Guerry Electric Co., will serve as Secretary-Treasurer.

Additional successful luncheons have since been held on March 3, April 7 and May 5.

Ohio Valley Section Sponsors Lighting Caucus

The full day conference at the Hotel Sinton, Cincinnati, March 31, lived up to its pre-meeting billing as a "colossal Lighting Caucus." Actually the meeting turned out to be a one-day convention, with 175 people attending, many from considerable distances. This was in line with the purpose of the meeting, since it was designed particularly to provide an opportunity for members living some distance from Cincinnati to attend a Section meeting. For such members, the caucus wrapped up light Section meetings, as it were, presenting eight outstanding speakers on highly educational subjects, plus a top tenderloin dinner and cocktail hour.

Arrangements for this successful proj-

(Continued on page 16A)

LIGHTING CALENDAR

Society Events

May 7, 1952—Meeting of I.E.S. Council Executive Committee, Cleveland, Ohio.

May 22-23, 1952—East Central Regional Conference, Webster Hall Hotel, Pittsburgh, Pa.

June 16, 1952 — Meeting of I.E.S. Council, Hotel Prescott, Swampscott, Mass.

June 19-20, 1952 — Northeastern Regional Conference, Hotel Preston, Swampscott, Mass.

July 10, 1952 — Meeting of I.E.S. Council Executive Committee.

September 8-13, 1952 — Illuminating Engineering Society, National Technical Conference, Edgewater Beach Hotel, Chicago, Ill.

Industry Events

May 4-8, 1952—The Electrochemical Society, Inc., National Convention, Benjamin Franklin Hotel, Philadelphia, Pa.

May 5-7, 1952 — Engineering Institute of Canada, 1952 Annual Meeting, Hotel Vancouver, Vancouver, B. C.

May 5-9, 1952 — 33rd Annual National Restaurant Association, Convention & Exposition, Navy Pier, Chicago, Ill.

May 6-9, 1952 — Fourth International Lighting Exposition & Conference, Cleveland Municipal Auditorium, Cleveland, Ohio.

May 8-9, 1952 — Public Utilities Advertising Association, Annual Convention, Hotel Radison, Minneapolis, Minn.

May 12-13, 1952 — Electrical Contractors Association of Ontario, Annual General Meeting, General Brock Hotel, Niagara Falls, Ont.

May 13-15, 1952 — Spring Meeting of the Pacific Zone, National Association of Electrical Distributors, Empress Hotel, Victoria, B. C.

June 2-5, 1952 — Edison Electric Institute, 20th Annual Convention, Cleveland, Ohio.

June 6-21, 1952 — International Organization for Standardization (ISO), General Assembly, Council and a Number of Technical Committees, Columbia University, New York, N. Y.

Week of June 9, 1952 — 44th Annual Convention, National Association of Electrical Distributors, Atlantic City, N. J.

June 9-13, 1952 — Third Annual Conference on Industrial Research, Columbia University, New York, N. Y.

June 23-27, 1952 — Summer General Meeting, American Institute of Electrical Engineers, Hotel Nicollet, Minneapolis, Minn.

Week of June 23, 1952—American Society for Testing Materials, 55th Anniversary Meeting, Hotels Statler and New Yorker, New York, N. Y.

June 30 - July 2, 1952—Canadian Electrical Association, Annual Convention, Banff Springs Hotel, Banff, Alta.

June 29 - July 7, 1952 — New York State Association of Electrical Contractors and Dealers, Inc., Saranac Inn, Saranac, N. Y.

July 6-11, 1952 — New York Lamp Show, Hotel New Yorker, New York, N. Y.

August 19-22, 1952 — Pacific General Meeting, American Institute of Electrical Engineers, Phoenix, Ariz.

September 8-10, 1952—American Standards Association's Third National Standardization Conference, Museum of Science and Industry, Chicago, Ill.

September 8-11, 1952 — Institute of Traffic Engineers, Annual Meeting, Hotel Sherman, Chicago, Ill.

September 29 - October 2, 1952 — Annual Convention, International Municipal Signal Association, Inc., Hotel Statler, Boston, Mass.

October 1-3, 1952—Canadian Electrical Manufacturers Association, 8th Annual Meeting, General Brock Hotel, Niagara Falls, Ontario.

October 1-4, 1952 — 17th Annual Conference, International Association of Electrical Leagues, Radisson Hotel, Minneapolis, Minn.

October 7-9, 1952 — Pacific Coast Regional Restaurant Convention and Exposition, Biltmore Hotel, Los Angeles, Calif.

October 13-17, 1952—Fall General Meeting, American Institute of Electrical Engineers, New Orleans, La.

October 20-21, 1952 — National Farm Electrification Conference, Hotel Statler, Detroit, Mich.

October 20-24, 1952 — 40th National Safety Congress & Exposition of the National Safety Council, Chicago, Ill.

November 10-13, 1952 — National Electrical Manufacturers Association, Haddon Hall Hotel, Atlantic City, N. J.

November 17-19, 1952 — 39th National Foreign Trade Convention, Waldorf-Astoria Hotel, New York, N. Y.

November 19, 1952 — 34th Annual Meeting, American Standards Association, Waldorf-Astoria Hotel, New York, N. Y.

January 19-23, 1953—Winter General Meeting, American Institute of Electrical Engineers, New York, N. Y.

March 9-13, 1953—National Electrical Manufacturers Association, Edgewater Beach Hotel, Chicago, Ill.

Week of May 24, 1953—45th Annual Convention, National Association of Electrical Distributors, Stevens Hotel, Chicago, Ill.

June 29 - July 3, 1953 — Summer General Meeting, American Institute of Electrical Engineers, Atlantic City, N. J.

August 18-21, 1953 — Pacific General Meeting, American Institute of Electrical Engineers, Vancouver, B. C.

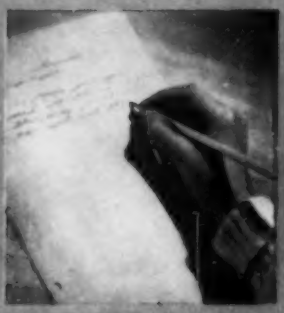
September 21-26, 1953 — 25th Jubilee Meeting, International Association of Electrical Inspectors, Edgewater Beach Hotel, Chicago, Ill.

November 9-12, 1953 — National Electrical Manufacturers Association, Haddon Hall Hotel, Atlantic City, N. Y.

Control of Light is Basic to

BAD. Harsh modeling shadows seriously interfere with needed three-dimensional seeing experience. Control of light is the answer.

GOOD. Soft, graded, "transparent" modeling shadows are necessary for three-dimensional seeing. Control of light is the answer.



BAD. Highly directional task lighting and resultant reflected glare make for unbearable contrasts. Control of light is the answer.

Control of Daylight

is accomplished with

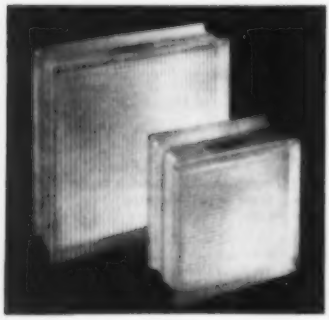
PC Functional Glass Blocks

With PC Functional Glass Blocks, the most exacting daylight control and distribution needs can be met without shading. They afford maximum daylight utilization, provide a cheerful daylight environment, add to architectural beauty—by day and night—and effectively complement the electric lighting system in the "Co-ordinated Classroom".

PC Functional Glass Blocks include two principal types. One type controls light by *bending or directing* it upward. The other type by diffusing it. The light-directing glass blocks, installed above eye level, have internal prisms that project incident daylight above the field of vision and thus distribute illumination with remarkable uniformity throughout the room. The light-diffusing glass blocks break up harsh rays and flood interiors with softly diffused light of high quality.

For complete information on daylighting buildings with PC Functional Glass Blocks, write to Pittsburgh Corning Corporation, Dept. Q-42, 307 Fourth Avenue, Pittsburgh 22, Pa.

Be sure to visit our Booth No. 313, 4th International Lighting Exposition, Cleveland, Ohio, May 6-9, 1952.



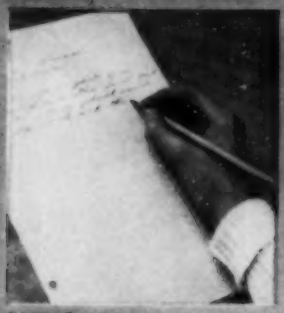
There are two types of PC Functional Glass Blocks—light-directing and light-diffusing. They are available in 8" and 12" square sizes.

ELEMENTARY SCHOOL, WESTERN SPRINGS, ILL.

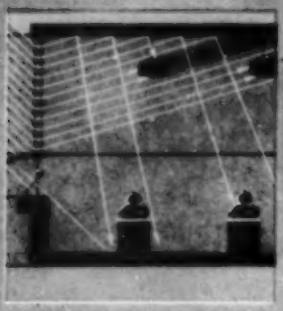
Here is an excellent example of a completely "Co-ordinated Classroom". Daylight is controlled, and co-ordinated with artificial light,

PITTSBURGH PC CORNING

the "Co-ordinated Classroom"



GOOD. Task lighting should distribute so as to be apparently shadow-free; reflected brightness less than that of task. Control of light is the answer.



BAD. Opaque luminaires reduce the efficiency of light-directing glass block and cast shadows on the ceiling. This works against control of light.

GOOD. Luminaires with minimum opacity and maximum translucency permit fullest transmission of daylight. This furthers control of light.

ARCHITECTS: BERGER, KELLEY AND SAMUELSON

by PC Functional Glass Blocks. Artificial light is controlled, and co-ordinated with daylight, by Wakefield luminous-indirect Stars.

Control of Artificial Light

is accomplished with

Wakefield Luminous-Indirects

Because the Wakefield Star (fluorescent) and Commodore (incandescent) have plastic reflectors whose brightness is about the same as the ceiling, no glare either direct from the luminaire or reflected from a glossy surface can meet the eye. *This is basic* to the "Co-ordinated Classroom".

Because the Wakefield Star and Commodore put most of the light on the ceiling, making the ceiling apparently the principal light source, light is distributed evenly all over the room in such a way as to provide soft modelling shadows for three-dimensional seeing. *This is basic* to the "Co-ordinated Classroom".

Because the Wakefield Star and Commodore have a minimum opaque cross-section (metal) and a maximum of translucency (plastic), fullest transmission of directed daylight is permitted to the ceiling. *This is basic* to the "Co-ordinated Classroom".

Wherever you see "Co-ordinated Classrooms" you will see Wakefield luminous-indirect luminaires providing the supplementary lighting. For complete information and helpful literature, write to The F. W. Wakefield Brass Company, Vermilion, Ohio.

Visit our Booths No. 301-302 at the 4th International Lighting Exposition, May 6-9, 1952, Cleveland, Ohio.

There are two types of Wakefield luminous-indirect luminaires—the STAR (fluorescent) and the COMMODORE (incandescent). Both have translucent Plaskon reflectors.

(Continued from page 13A)

ect were made by William V. Misrach, Ohio Valley Section Program Chairman. George H. Seiter, Section Chairman served as Chairman of the caucus, and Regional V P F. C. Winkler did a splendid job as moderator. Those responsible for this successful meeting recommend to other Sections and Chapters this means of serving a wide segment of the Section membership.

Program of the meeting, starting at noon, through the evening, included:

"Incandescent & Reflector Lamps"—by Kirk M. Reid, General Electric Co.
"Gaseous Discharge Lamps"—by Alfred Paulus, Westinghouse Electric Co.
"Fluorescent Lamps"—by R. M. Smart, Sylvania Electric Products Co.
"Ballasts"—by E. H. Salter, Electrical Testing Laboratories.
"Fixture Maintenance & Installation"—
"Commercial"—by Ray Hildebrecht, Edison Marquette Co.
"Industrial"—by C. W. Wright, Delco Div., General Motors.
"Public Hearing"—Chance to quiz the experts! Cocktails and Dinner.
"Sales Psychology"—by Stephen Douglas, The Kroger Company.

FOUR of the eight speakers, all I.E.S. Members, participating in the highly successful "Lighting Caucus" conducted March 31 by the Ohio Valley Section in Cincinnati. L. to r. F. C. Winkler, Great Lakes Regional V.-P.; R. M. Smart, Alfred Paulus, and Kirk M. Reid. Some 175 people attended the meeting.

Summary of Action Taken At April Council Meeting, Chicago

The presence in Chicago of many I.E.S. members, at the Edison Electric Institute meeting April 1 to 4, afforded an opportunity for a Chicago meeting of I.E.S. Council, and the attendance of several local members. The meeting was held March 31, prior to the E.E.I. conferences, at the Edgewater Beach Hotel. Present were: S. G. Hibben, President, presiding; Past Presidents, C. H. Goddard and Walter Sturrock; Vice Presidents, G. K. Hardacre proxy for A. H. Manwaring and E. M. Strong; General Secretary, C. C. Keller; Treasurer, R. F. Hartenstein; Directors, L. V. James proxy for G. W. Beals; J. R. Chambers proxy for R. L. Biesele, Jr.; H. P. Steele, proxy for L. A. Hobbs; M. N. Waterman proxy for D. M. Jones; R. J. Diefenthaler proxy for R. A. Palmer; A. F. Wakefield proxy for J. S. Schuchert; Regional Vice Presidents, W. V. C. Foulks proxy for W. E. Folsom, P. H. Hildebrand, C. N. Laupp, R. C. Paslay, R. G. Stauer; A. D. Hinckley, Executive Secretary; C. L. Crouch, Technical Director; Ruby Redford, Editor; C. E. Ellis, Advertising and Promotion Manager; and W. C. Brown, R. B. Burton, Sr., E. H. Church, E. C. Huerkamp, P. F. Kauffman, C. K. Lambka, R. R. Lusk, J. E. Mueller, L. B. Paist, C. C. Shotwell, L. E. Tayler, L. C. Twichell, W. A. Weibel.

Those attending Council for the first time heard the Society's officers conduct Council business, including reports on financial status, progress reports from a number of committees, and discussion on many pertinent matters.

Action taken included the election to membership in I.E.S. of 20 Members, 64 Associate Members and 5 Students. Membership totals were reported as follows:

September 30, 1951		March 31, 1952
7166	Total Membership	7452
32	Members Emeritus	33*
42	Fellows	43
1709	Members	1760
5174	Associate Members	5354
209	Student Members	262

*Includes 10 Fellows.

New Sustaining Members

C. C. Shotwell, Chairman of the Sustaining Membership Committee presented for Council's approval, four Sustaining Members, and action was taken electing:

Continental Electrical Construction Co.
3540 Southport Avenue
Chicago 13, Ill.
Official Representative: Leo W. Witz

Gragco Products
3830 N. Keeler Avenue
Chicago, Illinois
Official Representative: A. E. Orelove

Guardian Light Company Inc.
301 Lake Street
Oak Park, Illinois
Official Representative: W. S. Akely

Wasco Flashing Company
87 Fawcett Street
Cambridge, Mass.
Official Representative: Selig M. Friedberg

Medal Award To H. H. Magdsick

Unanimous action of Council on the recommendation of the Medal Award Committe was taken, naming Herbert H. Magdsick the recipient of the I.E.S. Gold Medal Award for 1952. A full report of Mr. Magdsick's election to this honor is scheduled for the June issue of Illuminating Engineering.

Local Activities

E. F. Strong presented the Local Activities report for A. H. Manwaring indicating progress of five guides underway for guidance on procedure in conducting local Society affairs.

These included:

Section and Chapter Guide
Section and Chapter Meeting
Student Branch Operation
Chapter Organization
Study Club

His report also indicated wide participation in the current Society contests for "My Most Interesting Lighting Job." Several local contests have already been

(Continued on page 20A)

Diffused Lighting... with PLEXIGLAS

You may well think you are under a naturally-lighted skylight when you visit this gallery at the Museum of Fine Arts in Boston. The effect, however, is obtained by the use of translucent white diffusing panels of PLEXIGLAS acrylic plastic, mounted below fluorescent lamps.

PLEXIGLAS luminous ceilings provide high quality lighting in eight new exhibition rooms at the Museum. The totally *diffused* illumination is free of shadows and reflected glare. The effect of daylight, the most desirable condition for human vision, is achieved and the disadvantages of depending upon natural light, with its constantly shifting values, are eliminated.

The even spread of artificial light across the PLEXIGLAS surfaces and the absence of visible lighting fixtures make the luminous ceilings architecturally appealing. Higher light intensity and full color values for the paintings are supplied by directional louvers and recessed spotlights.

PLEXIGLAS luminous ceilings satisfy the requirements of architects and lighting engineers for low brightness ratios, high illumination levels, excellent diffusion, and fixture-free appearance. In addition, the lightweight yet strong diffusers are removed easily and safely for cleaning and for access to the lighting source, resulting in a sustained high level of lighting performance.

If you have a lighting problem, investigate "daylighting" with a PLEXIGLAS luminous ceiling. We will be glad to send you technical details about the installation shown above. Write for them.

The Rohm & Haas exhibit at the Fourth International Lighting Exposition and Conference, May 6-9, Public Auditorium, Cleveland, Ohio, will be in Booth 153.

Special Galleries, Museum of Fine Arts, Boston, Massachusetts. Architects: Leland and Larson, Boston. Illuminating engineers: Thompson Engineering Company, Boston. Photograph courtesy of General Electric Company.

CHEMICALS FOR INDUSTRY

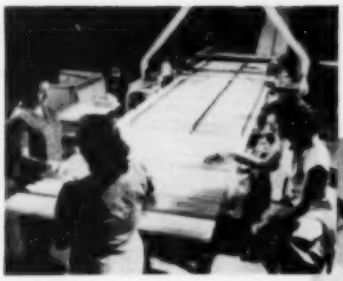
ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

Representatives in principal foreign countries

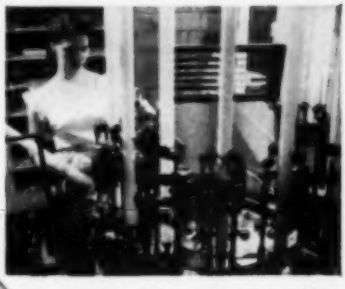
PLEXIGLAS is a trademark, Reg. U.S. Pat. Off. and other principal countries in the Western Hemisphere.

Canadian Distributor: Crystal Glass & Plastics, Ltd., 190 Queen's Quay at Jarvis Street, Toronto, Ontario, Canada.



This tremendous sphere measures light output. This exacting test is only one of the 247 tests imposed on Westinghouse fluorescent lamps to insure maximum lighting economy.

In this all-important step, skilled workers check the coating of Westinghouse fluorescent lamps to see that it is perfectly uniform and free of flaws.



Here the electrode is carefully sealed into the lamp prior to the air-exhaustion and injection of the krypton-argon starting gas.

Lamp Division
Westinghouse Electric Corporation
Bloomfield, New Jersey

YOU CAN BE **SURE**...IF IT'S

Westinghouse

more light, more savings

Real savings are made possible with this new Westinghouse 90-watt fluorescent lamp, and here's why . . .

This new lamp gives 6% more light than the 85-watt fluorescent lamp, yet uses only 2% more current. What's more, its high light output is consistent, for even after 7500 hours of operation it still out-produces any other lamp in its class.

In short, there's top lighting value from this new economy-size fluorescent tube! For any industry or business looking for better lighting at lower cost, this is the tube to use.

NEWS FROM WESTINGHOUSE, THE FASTEST-GROWING LAMP MANUFACTURER

by Sam Hibben

DID YOU KNOW?

Many deep sea fish have built-in fluorescent lights, but one of them has a twist: The sub-order Ceratioidea has its fluorescent lamp on the end of a pole! Smaller fish go after this luminous bait, and wham—they get eaten. The trick, I suppose, is how to keep big fish from going after the bait—but big ones seldom go that deep, and many lighted-up fish can dim out at will.

Fish, incidentally, have—like onions, cabbage or dozens of other foods—wholesome but penetrating odors when cooked. Westinghouse has just introduced a tiny lamp that destroys odors—it really does. The lamp puts out rays that create ozone, and the ozone oxidizes the floating molecules of most common odors. It's easier to operate than explain, but it costs only about 5¢ a week to burn and it keeps air fresh and sweet.

A THOUGHT FOR THE DAY:

Your eye lenses act much like a camera's. This means that the image on your retina is upside down. That is, the top of a tree registers on the bottom of the eyeball. You've simply learned to interpret it around again after the electric impulses have carried the "television" picture to the brain. Had you known you were that smart, or does the world still look upside down?

More next month.

Samuel G. Hibben

WESTINGHOUSE LAMP DIVISION Dept. AE
BLOOMFIELD, NEW JERSEY

I'd like to know more about the new 90-watt Westinghouse Fluorescent Lamp.

NAME .....

COMPANY .....

ADDRESS .....

CITY ..... STATE .....

WESTINGHOUSE FLUORESCENT LAMPS STILL COST LESS THAN THEY DID IN 1940, YET BURN SEVEN TIMES LONGER!

(Continued from page 16A)

completed, with the winners set to compete on the next level, the Regional Conferences.

New Chapter in Peoria

C. N. Laupp, Midwestern Regional V P, presented a petition for Charter to establish a new I.E.S. Chapter in Peoria, Illinois, formed by members released by the Chicago Section. The petition indicated the group met all Constitutional requirements and carried the Chicago Section's and Mr. Laupp's recommendation of favorable action. Council approved the granting of a Charter to this new group, to be known as the Central Illinois Chapter.

From other regional V P's additional new Chapters appeared to be in prospect in Birmingham, Ala., Memphis, Tenn., Richmond, Va., Green Bay, Wisc., Duluth, Minn., Albany, Troy and Schenectady in New York, Columbus and Dayton, Ohio, Albuquerque, San Diego and San Jose, California.

Rochester Section

On petition from the Rochester Chapter, presented by L. C. Twichell in the absence of Regional V P F. C. Winkler, Section status was approved for this group.

Historical Committee

One Committee report of especial interest was that presented by Mr. R. B. Burton, Sr., Member Emeritus, Chairman of the Historical Committee. Mr. Burton showed some results of a very thorough survey he had made on the history of the lighting fixture industry from its inception, together with a bibliography on this subject dating from 1802. Interesting museum piece pictures pertaining to the history of lighting as an industry were examined by Council.

The General Secretary reported communication from C. O. Martin, Vice President South Pacific Coast Region, indicating action by the Regional Nominating Committee to name Leonard A. Hobbs Regional Vice President for the South Pacific Coast Region in the term beginning October 1, 1952. He then presented Mr. Hobb's letter submitting his resignation as a Director of the Society for the remaining term of his office in order that he may serve the Region as Vice President.

See list of Sustaining Members, starting page 31A

LUMINOUS SIGN of the New England Section, I.E.S. poses with some of the members of the Section's Executive Committee, who are: (seated) B. B. Brown, Jr.; W. E. Schwanhausser, Secretary-Treasurer of the Section; F. J. Vorlander, Section Chairman; J. W. Young; and (standing) W. B. Kennedy; E. J. Perkins; L. S. Cooke; H. C. Mayer, substituting for D. T. Carter; Philip N. Bugg.

Luminous Sign Identifies New England Section, I.E.S.

No matter where the New England Section holds its meetings, that location can now be marked as an I.E.S. activity. A luminous sign of acrylic plastic, two feet in diameter and five inches deep, internally coated with plastic coloring of the I.E.S. Emblem and striping in royal blue on a golden yellow background, and internally lighted by a cold cathode circular tube, is placed in the lobby outside the monthly meeting rooms to serve both as an identification and as a guide to members and visitors. The sign was donated to the Section by Mr. Joe Donovan, President of Colorvision Plastics, Inc., Boston.

The Section intends also to use the sign at the Northeastern Regional Conference in Swampscott, Mass., June 19 and 20.

Home Lighting Exposition Planned in Miami

The Southeast Florida Chapter of I.E.S. is planning an educational exposion, featuring proper home lighting and the latest developments in the field of illumination, to be held next autumn. Architects, builders, interior decorators and electrical engineers in the vicinity have been meeting with Jacob H. Blitzer, residential lighting chairman of the Chapter, to map their program.

Scheduled for November 20, the exposition will aim at educating the public on the type of light sources required for the home and will demonstrate how light can be used to decorative advantage.

Serving on the committee of sponsors with Mr. Blitzer, are:

Newt. H. Bollinger, Chairman of the Chapter,
R. W. Bostwick, Florida Power & Light Co.,
Dr. Frank B. Lucas, School of Engineering, University of Miami,
Robert Fitch Smith, South Florida Chapter, American Institute of Architects,
Mrs. Marion Jones, associate professor of Home Economics, University of Miami.

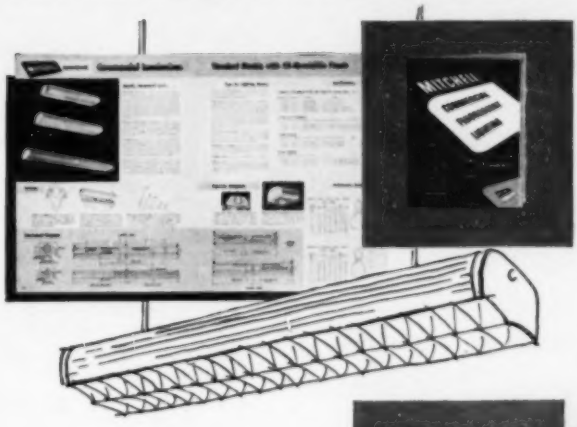
Three Plans Underway for U. S. Technical Publications Needed Abroad

Support for programs to meet the pressing needs of other countries for technical and professional books has been urged by the U. S. National Commission for UNESCO. Three main plans are now in operation in this country. The UNESCO-CARE book buying program, inaugurated 1944, is aimed to meet the most specific requirements for scientists, educators, teachers and students. The U. S. Book Exchange is another medium for both gift and exchange operations. A third device, aimed to overcome currency barriers to the distribution of publica-

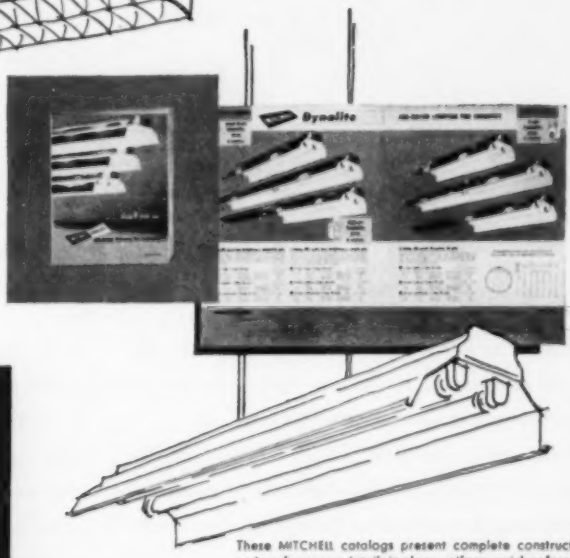
(Continued on page 23A)

mitchell lighting easiest to specify

save time, specify properly for every lighting need with these 2 data-packed catalogs



Commercial Fluorescent Lighting
More than 70 superb Commercial Luminaires, described in detail—for quick, tailored-to-the-job specification.



"Dynalite" Lighting for Industry
You'll find it easy to specify for any industrial installation. Choose from 82 *Dynalite* Job-Rated units.

These MITCHELL catalogs present complete construction and performance details in clear, uniform, quick-reference style. You get application data, specifications, features, dimensions, curves for every model—for quick, proper specification and installation planning.

Where Quality Counts— SPECIFY MITCHELL!

Quality is not just a word—it is an important tangible that can be seen and measured in every MITCHELL lighting unit. These superbly engineered fixtures are built to the most exacting standards for easy, time-saving installation—for low-cost maintenance—for dependable, long-life, efficient performance. Where quality with sensible initial cost must be your most important considerations, in either commercial or industrial lighting—be sure—specify MITCHELL!

MITCHELL
Manufacturing Company
Chicago 14, Illinois

SEND FOR BOTH

MITCHELL

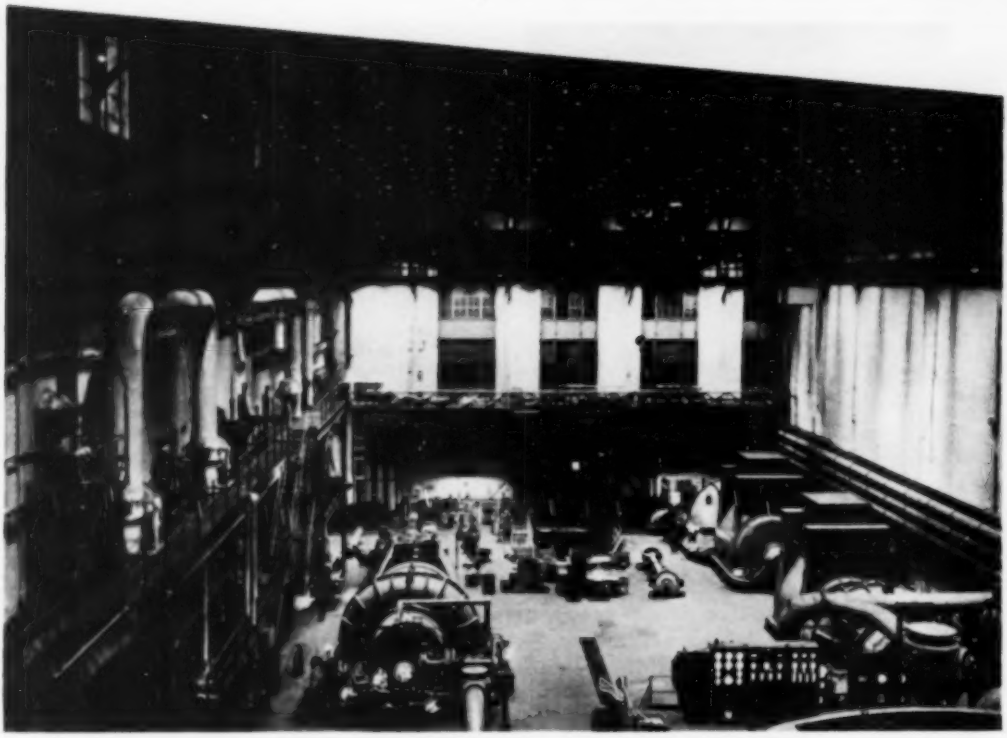
Mitchell Manufacturing Company, Dept. 3-E
2525 N. Clybourn Ave., Chicago 14, Ill.
Please send Commercial and Industrial Lighting Catalogs.

Name_____

Firm_____

Address_____

City_____ Zone____ State____



QUALITY LIGHTING

The lighting industry preaches the idea that adequate expenditure for proper lighting is a good investment—but we don't always practice it.

Not so the Consolidated Edison Company of New York who recently found it desirable to modernize the lighting of their Turbine Room at their Waterside Power Plant.

The installation comprises 186 suspended 1000-Watt Rambusch Bi-Post Downlites especially adapted for easy relamping from top of crane. In addition, 14 Special Rambusch Shovel Downlites are mounted on the catwalk spanning the eastern end wall. All units are mounted on vibration absorbers to avoid transferring building vibrations to the lamps.

Units are spaced approximately 8′ x 14′ on centers and are suspended 85′ above floor level, and deliver better than 40 f.c. at average work level after more than one year in service.

Experienced lamp life is 1100 hours (the T-24, 1000-Watt, Medium Bi-Post lamp, which is used, has a rated life of 1000 hours).

Selection of the Rambusch Downlite was based upon its positive light control, its glare-free appearance and rugged construction.

DESIGNERS · MANUFACTURERS

RAMBUSCH **40 WEST 13th STREET, NEW YORK 11, N. Y.**

(Continued from page 20A)

tions, is the UNESCO Book Coupon scheme.

The CARE book program calls for the purchase and shipment of book packages "to meet the hunger of the mind" in much the same way that CARE food packages are handled. The book packages, and a few magazine subscriptions, are consigned to institutions rather than individuals and the program is operated in this country through national organizations. Shipment and handling is arranged through the CARE headquarters at 50 Broad Street, New York City.

Operations of the U. S. Book Exchange involve contacts with 260 libraries in 50 foreign countries, as well as 200 libraries in the U. S. The exchange of publications is the long-range objective of this operation, rather than the donation program of its predecessor, the American Book Center.

The Exchange concentrates on research materials of all types—books, pamphlets and periodicals—in fields ranging from the sciences to literature, art, history and philosophy.

The UNESCO Book Coupon Scheme is designed mainly to help overcome the difficulties of soft-currency countries in obtaining publications. Unable to purchase books and periodicals with their own money, institutions and individuals in soft currency countries can place orders in hard currency countries or among themselves through use of UNESCO coupons — with UNESCO paying supplying countries in their own currencies. The coupon plan has been described by Luther Evans, Librarian of Congress, as "an outstanding example of UNESCO's practical approach in overcoming one of the toughest obstacles to the free flow of information among peoples."

Educational Program Announced For Young Engineers

A new educational program, designated as the Westinghouse-John Hopkins Awards in Electrical Engineering for 1952, has been established to help young people pursue careers in the field of electrical engineering. The awards will enable thirty students a year to combine work experience at Westinghouse with technical studies at the McCoy College of The Johns Hopkins University.

ONLY FRENCH speaking Chapter in I.E.S., in Quebec, Canada. With meetings conducted in French, this Chapter has grown in size and in local renown, attracting high attendance to some eight meetings each year.

Illumination Is Vital Phase Of Army Research Program

In a report by the Engineer Research and Development Laboratories, Fort Belvoir, Va., on the Trends for Engineer Research and Development, illumination for military purposes is listed as an important need of the Corps of Engineers. Searchlight units are again in demand for tactical purposes in Korea. Basic studies in high intensity light sources and the techniques of most effective utilization are underway. The improvement of infrared equipment, proven effective in the Okinawa campaign, for night combat is also a chief concern.

Lighting Session Featured At Electrical Industry Convention

Commercial, industrial and residential phases of lighting were featured at the All-Industry Lighting Meeting of the 1952 Electrical Industry Convention and Trade Exposition, in St. Paul, Minn., February 24 to 28. Sponsored by the North Central Electrical Industries, the convention was attended by delegates from Minnesota, North and South Dakota and Iowa.

The meeting on lighting consisted of speeches by Don Caverly, Sylvania Electric Products, Inc., who covered the topic of commercial and industrial lighting for defense; Carl Jensen, Westinghouse Electric Corp., who presented a demonstration of new lighting applications; Mrs. Folke Victorsen, Minneapolis home building contractor and L. H. Hruby, General Electric Co., who appeared together to give the home builders' viewpoint. Louis Riegert, chairman of the Twin City Section of I.E.S. presided as master of ceremonies.

C.L.I. Spring Program Now Underway

The Spring Quarter Program of the Chicago Lighting Institute offers Part II of the course on Electricity in Commercial Buildings, a continuation of the classes in the Winter Quarter. The ten meetings of this course are being held every Wednesday, April 9 through June 11. Instructors are: Wiring—Frank R. McShane; Lighting—E. F. McDonnell, Jr.; Air Conditioning—G. Gill Freyder.

The lecture and laboratory sessions in the Lighting Fundamentals Course, given during the Winter Quarter, are being repeated with Robert Ligare again instructor for the lectures and William Richards for the laboratory sessions. The twelve lectures run from April 8 through June 24 and six laboratory meetings are held every other Thursday from April 10 through June 19.

(Telecast Continued on page 24A)

Installations To See in CLEVELAND

Class of Job	Installation at	Address	Interesting Features
Artist's & Drafting Room Supplies Store	B. K. Elliott Co.	636 Huron	Fluorescent and filament lighting, all glass front
Bank	Bank of Ohio	921 Huron	Large custom-made luminous elements
Bank	Central Natl. Bank	509 Euclid	Large-cell louverall, luminous ceiling, filament downlights
Bank	Central Natl. Bank	123 W. Prospect	First plastic ceiling in Cleveland; recessed downlighting, surface-mounted slimline
Bank	Playhouse Square Central Natl. Bank	1718 Euclid	Luminous ceiling, luminous elements
Cathedral	St. John's (Catholic) Open 6:30AM-9PM	1007 Superior	Lanterns and downlighting
Cathedral	Trinity (Episcopal) Open 8AM-5PM Daily	22nd & Euclid	Lanterns with decorative lighting in nave
Church	St. Paul's (Episcopal) Open 9AM-5PM Daily	Fairmount & Coventry	Modernistic interior with downlighting, some fluorescent in stairwells, floodlighting in tower
Conference & Teaching Center	G.E. Lighting Institute	Nela Park	Many types of lighting, exhibits and demonstrations
	Conducted tours 10AM & 3PM, Mon. thru Fri., Open House 7-10PM Tuesdays)		
Customers' Room	Cleveland Electric Utility Company	75 Public Square	Ceiling recessed fluorescent luminaires with glass lens plates
Dept. Store	Higbee Co.	Public Square	Show windows; recessed downlights and perimeter lighting in Sports Center
Dept. Store	Sterling-Lindner-Davis	13th & Euclid	All-round good store lighting
Electrical Manufacturing	Westinghouse Elec. Corp. (Contact W. P. Werner, CH-1-7600)	1216 W. 58th St.	Office, commercial, industrial and other types of lighting
5 & 10c Store	F. W. Woolworth Co.	308 Euclid	High-level De Luxe cool white installation
Floodlighting	Interesting examples are to be seen at Cleveland Health Museum, 8917 Euclid, Cleveland Museum of Art, Wade Park, and Cleveland Municipal Stadium, West 3rd on the lakefront.		
Florist Shop	Ethel L. Dryfoos	1820 E. 13th	Effective use of spots for atmosphere
Florist Shop	Jones Russell, Inc.	1026 Euclid	Combination fluorescent and filament lighting
Florist Shop	G. W. Mercer, Inc.	1418 Euclid	Combination fluorescent and filament
Furniture Store	Aldrich-Howey Co.	2121 E. 4th	False ceiling built around suspended slimline luminaires
Furrier's Shop	I. J. Fox	328 Euclid	Recessed fluorescent and filament; all-glass front
Jewelry Store	Rudolph Deutsch	1501 Euclid	Good sales and atmosphere lighting
Library	Cleveland Pub. Libr.	325 Superior	Well-lighted reading rooms and experimental stack lighting units
Library	E. Cleveland Pub. Libr.	14101 Euclid	Filament indirect and fluorescent direct through skylight
Library	Shaker Heights Libr.	3450 Lee	Troffer lighting
Newspaper Commercial Office	Cleveland Plain Dealer	6th and Superior	Geometric system of hollow squares—4-lamp slimline luminaires
Outdoor Sports Lighting	City of Euclid, Ohio		190-light football field; 178-light baseball field; 90-light softball field
Porcelain-Enamel Mural	Concourse	Cleveland Union Terminal	Specular reflections, once very bothersome, eliminated by spraying surface with dull lacquer
Restaurant	Fred Harvey	Union Terminal	Unusual louvered elements
Stationery Store	Burrows	419 Euclid	Troffers and downlighting
Street Lighting	Over 1000 miles of Greater Cleveland streets are lighted in accordance with American Standard Practice for Street Lighting. No other city in the country has as much mileage of streets lighted to American Standards.		
Synogogue	Park Synogogue	3325 Euclid Hts. Blvd.	Huge dome, cove-lighted with reflector lamps
	(Call Synogogue, ER-1-2244 for appointment)		

Compiled by Cleveland Section, I.E.S.

(Telecast continued on page 27A)

Now...

added to the Silvray line of special-effect lighting units —

THE SILVER-DOT RECESSED DOWNLIGHT

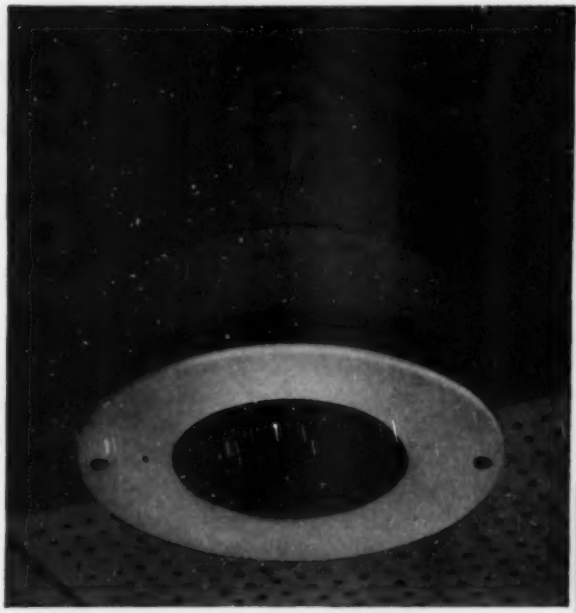
Featuring complete concealment of the light source, this compact Silver-dot unit rounds out Silvray's line of all-purpose incandescent downlights.

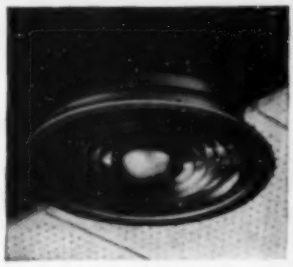
Employing a 4" ceiling aperture for passage of a precisely-focused light beam, the Silver-dot is ideally suited for supplementary accent or special-effect lighting in commercial and residential interiors.

Silver-dot units are designed for use with the new 100-watt A-21 clear silvered-bowl lamp. They produce more candle power than equipment using 150-watt reflector or projector lamps ...use less energy...generate less heat.

Placed 6' above the surface to be lighted, for example, the Silver-dot casts a 6' glare-free light circle. Relamping, without removing the ceiling plate, restores the unit to initial efficiency.

Easy to install, the Silver-dot requires a ceiling opening only 6½" in diameter...a recess depth of only 7¼".





THE SILVER-SPOT

Companion piece to the Silver-dot, this versatile, general-purpose downlight is available for both recessed and surface-mounted installations. 10⅛" in diameter, the Silver-spot requires an opening depth of only 5⅛" for complete recessing . . . projects only 3½" when surface mounted. Precision light control of built-in reflector eliminates glare and wasted spill light. Louvre provides 45° shielding.

THE SILVER-SPOT ADAPTOR

Designed as a portable unit, this 8" diameter version of the Silver-spot is equipped with a "screw-in" adaptor base to fit standard porcelain receptacles or swivel fittings. Both the Silver-spot and Silver-spot Adaptor unit use the 100-watt A-21 lamp to obtain the warm color quality so much in demand by merchandising experts. Both units are easily convertible to either floodlight or spotlight distribution.

SEND FOR COMPLETE DETAILS

SKYLIKE LIGHTING, INC. — A Silvray-associated company
104 West Main Street, Bound Brook, New Jersey

Gentlemen:

Please send me further information on Silver-spot and Silver-dot units.

Name_____

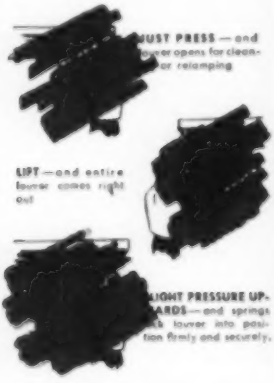
Firm_____

Address_____

City_____ Zone____ State_____

New! Exclusive "Spring-a-matic" Louver Action

Another ELECTRO advancement! The easiest, safest, fastest device for opening and closing louvers ever developed. Two hidden springs hold "Surf-A-Lite" louver firmly in place. No screws, bolts or other mechanical gadgets to work loose, drop out or get out of order.



New ELECTRO "Surf-A-Lite" with Styrene louvers

Now—the smart, neat appearance of a surface mounted flourescent fixture—and greater lighting efficiency as well! The new, shallow "Surf-A-Lite" incorporates ELECTRO'S improved plastic louvers and a metal reflector plate to utilize more downlight . . . achieve better general diffusion . . . give increased lighting efficiency overall.

Wherever specifications indicate the desirability of a flush mounted flourescent luminaire, select the more attractive appearance and superior lighting ability of the new ELECTRO "Surf-A-Lite".

- Lustrex styrene plastic louvers are guaranteed not to warp or discolor under normal use for the life of the fixture.
- The "Surf-A-Lite" can be used for pendant mounting as well as surface mounting by easy removal of reflector plates.
- "Surf-A-Lite" hugs the ceiling for that recessed "look" . . . helps end "ceiling clutter".
- No visible screws, hinges or other metal devices.
- Side Panels available in metal or in translucent Lustrex styrene plastic.
- Improved 45°—37° Shielding.
- For individual or continuous mounting.
- In 4 lamp and 2 lamp, 40 and 20 watt models.
- Also in 4-6-8 ft. SLIMLINE.

AVAILABLE THROUGH LEADING ELECTRICAL WHOLESALERS EVERYWHERE

ELECTRO MANUFACTURING CORPORATION

2000 W. FULTON ST. • CHICAGO 12, ILLINOIS

(*Telecast continued from page 24A*)

New York's First Annual Electrical Trade Exhibit

An Electrical Trade Exhibit was held at the Commodore Hotel, New York, March 26th, 27th and 28th under the sponsorship of the Lighting, Lamp and Electrical Manufacturers Salesmen's Association. Harry Levenstein was chairman of the Exhibition Committee.

The exhibition occupied the entire first floor of the hotel and consisted of exhibits by leading manufacturers of lighting equipment.

Research Grant for Study of Environmental Factors in Seeing

A research fund of $10,000 has been established at the Massachusetts Institute of Technology by the F. W. Wakefield Brass Co., Vermilion, Ohio, for study of all environmental factors contributing to the process of seeing; to provide a center for investigating the effects of various distributions of light, heat, sound, air movement and other energy factors upon task performance, and methods and equipment for controls of these factors; and to collate researches in physiology, ophthalmology, optometrics and other fields which have bearing upon seeing. The grant was made to the School of Architecture of M.I.T.

New NEMA Standards Available

NEMA Standards — The following standards are available from the National Electrical Manufacturers' Association, 155 E. 44th St., New York, N. Y., at the prices quoted.

NEMA Standards for Electric Power Connectors, SG1-1952. This revision of Publication No. 57-47 contains standards for the current ratings of bare copper and aluminum conductors; rated frequency; basis of temperature rise; identification marking; thread dimensions; and bolts, nuts and lockwashers for connectors. Information is also given concerning the temperature rise, resistance, strength and ratio influence voltage tests. Various types of connectors are defined and classified. Price, $2.00 per copy.

NEMA Standards for Color Markings for Electrode Identification, EW2-1952. This supersedes Publication No. EW2-1950 and identifies by color all arc-welding electrodes for which a standard identification has been established. Price, $0.25 per copy.

NEMA Standards for Automatic Circuit Reclosers, SG13-1952. This new publication deals with automatic circuit reclosers which are self-contained devices for automatically interrupting and reclosing an alternating-current circuit. Specific information is given concerning the rating, manufacturing and testing of such circuit reclosers, and a separate section of the book gives instructions for installation, operation and maintenance. Terms used throughout are defined. Price $2.00 per copy.

EEI-NEMA Standards for Distribution Fuse Links, 108-1952. These standards cover current ratings and time-current characteristics of universal fuse links for use in enclosed, open and open link types of distribution cutouts for alternating-current distribution system or circuits, 601 to 15,000 volts, inclusive. Price, $0.15 per copy.

ABOUT PEOPLE

J. Mason Guillory, formerly manager of the Industrial and Commercial Division of New Orleans Public Service Inc.'s Industrial Engineering and Utilization Department, has been appointed director of advertising for that company, following the resignation of **W. J. Amoss**. Mr. Guillory has been with Public Service since 1931, serving in various engineering and sales positions. Other personnel changes in the Industrial Engineering and Utilization Department are: promotion of **John F. Morton** to the position of manager, with **James L. Campbell** manager of the Commercial Division and **Charles J. Sinnott** manager of the Residential Division.

Henry J. Chanon, who has served for the past year as manager of General Electric's Lighting Institute at Nela Park, has been appointed manager of Original Installation Sales for the company's Lamp Division. **James C. Forbes**, for the past three years supervisory engineer for the New York Sales District, has been named to replace Mr. Chanon.

G. South Dunn has been appointed assistant to the president of Curtis Lighting, Inc. Mr. Dunn has been acting as public relations director for several utility companies.

The appointment of **Ira G. Deitrick** to succeed **F. S. Kinsey** as manager of the Eastern District, Westinghouse Lamp Division, has been announced. Mr. Kinsey is now manager of government sales with headquarters in Washington.

A new lighting design, consultation and representation firm, Artech Design Associates, has been formed under the direction of **Jerry J. Silvers** and **Mitchell Bobrick**, illuminating engineers and designers.

Cornelius Elsasser, Jr., has been appointed Eastern District Manager of Unistrut Products Co., and will have his office at 74 Woolsey St., Irvington, N. J.

Corning Glass Works has announced the opening of a new sales district office in Washington, D. C. and the appointment of **Charles L. Day** as manager. Mr. Day will act in a liaison capacity between Corning and the various agencies and governmental departments. His office is Room 616, Kass Bldg., 711 14th St. N. W., Washington, D. C.

Electro Mfg. Corp., Chicago, Ill., has appointed **J. A. Witter** as sales representative for western Pennsylvania and West Virginia. Mr. Witter will have headquarters at 4024 Dowling St., Pittsburgh, Pa.

Max D. Gruber has returned to active participation in the lighting industry as a representative for several lighting equipment manufacturers and has his office at 235 W. 58th St., New York, N. Y.

Harry Walker has been appointed Greater Kansas City territory sales representative for the Mitchell Manufacturing Company, Chicago, and is located at 406 West 34th St., Kansas City, Mo.

IT SEEMS TO ME

This refers to the article entitled "Daylighting in Classrooms" by R. A. Boyd, which appeared on page 21 of the issue for January 1952.

Dr. Boyd's use of an illumination of one thousand footcandles for an overcast sky on an exterior vertical surface is contrary to the recommendation of the "Recommended Practice of Daylighting" as shown in paragraph 6.2 and is also unrealistic in light of Table I of these same Recommended Practices. According to Table I, the sky brightness for an average overcast day exceeds two thousand footlamberts only at noon for latitudes of 34° North or less, in the entire period from September to March 21 which comprises most of the school year. Rather roughly, the sky brightness of two thousand footlamberts corresponds to the vertical surface illumination of one thousand

footcandles that Dr. Boyd uses as a standard figure.

By private communication we have been informed that over a two-year period, the maximum vertical surface illumination including ground reflectance on a surface facing south, for Dallas, Texas, was 704 footcandles for an overcast sky.

Even with his unusually high illumination for an overcast day, Dr. Boyd's Figure 2B shows the inside row of desks as failing to attain 30 footcandles. In Figure 3, the minimum of 30 footcandles is attained only when the contribution from the clerestory is included, and in Figure 4B the minimum illumination is only 24 footcandles.

Considering the fact that for the recommended average overcast day these interior illuminations would be about 50% or less of that recommended for use in schoolrooms, I would like to point out that brightness ratios are only one of the attributes of good quality in lighting, and one could hardly claim good quality when quantity is less than half of that recommended.

Since Dr. Boyd's "direct reading objective type" brightness meter has not been described, it is rather important that Dr. Boyd tell what the area of the field which he observed is for the brightness values that he shows. For example, are these values for a field having the size of one square inch, one glass block, or several blocks including the mortar joints? — W. J. ARNER, *Libey-Owens-Ford Glass Company, Toledo, Ohio.*

Publication of the following letter has been withheld until now, pending a possible reply to the copy submitted to Prof. Weston.

It came as a distinct shock to read in ILLUMINATING ENGINEERING for April 1951 (Letter to the Editor by Prof. Weston, Institute of Ophthalmology, London, discussing a paper by Prof. R. L. Biesele, Jr.) that you believe the one-to-one ratio of task to surround brightness is a "fictitious ideal."

There are two points which I would like to discuss with you in connection with this statement, the accuracy of which I believe to be debatable in the light of present available knowledge.

In the first place there are data which do show maximum effectiveness of a visual function when the brightness ratio (central:surround) is unity. I refer you to Cobb's "The Effect on Foveal Vision of Bright Surroundings (IV)," *Journal of Experimental Psychology*, Volume 1 (1916), page 540. Cobb's criterion was not visual acuity but "minimum perceptible brightness difference, which I personally believe to be a better indicator of the true deleterious effect of brightness ratio. You are probably familiar with these data and know that it is shown in the paper that the minimum perceptible brightness difference was achieved when the brightness ratio was unity, and that the minimum perceptible clearly increased as the brightness ratio departed from unity in either direction.

In the second place it is my contention that the measurement of visual acuity is not an adequate criterion insofar as determinations of visual comfort are concernesl. Lythgoe's curve showing the attainment of maximum visual acuity at a test object brightness of 40 footlamberts with the surroundings at a brightness of 0.011 footlamberts clearly demonstrates the inadequacy of the criterion. Introspective appraisal of the situation should leave no doubt in the mind of anyone versed in the art that the task would be a highly uncomfortable one to perform, *for any normal period of time.* I am delighted with the data, however, because they do clearly show that the factor of brightness ratio can not be ignored by those devoted to the footcandle.

As indicated above, I think the factor of Time has not yet been duly considered in determining the true influence of other than unity Brightness Ratios. I believe that a Brightness Ratio which might prove acceptable for a brief exposure could easily cause considerable discomfort if endured for a matter of hours.

The subjective appraisals of the matter with which I have been connected leave little doubt in my mind that from the standpoint of Comfort the one-to-one ratio *is* quite probably the ideal, and that the ratio of Task Brightness to Surround Brightness should not exceed three if acceptably comfortable seeing conditions are to prevail for critical prolonged visual tasks such as are found in an office.

There is one other question upon which I would be interested in learning your opinion. In this country we are seeing a great deal of expediential engineering with regard to the limiting brightnesses for surfaces in the surrounds (in excess of the brightness of the task). There are those who still blithely contend that a brightness ratio between the task and surroundings of one to three is not much different than one of three to one. Except from the standpoint of expediency, do you think there is any justification for this? — WILLIAM G. DARLEY, *Consulting Engineer, Austin, Texas.*

NEW MEMBERS

At the meeting of the Council Executive Committee held in Chicago, Illinois on March 31, 1952, the following were elected to membership:

BRITISH COLUMBIA SECTION

Members:

Donnelly, P. A., Northern Electric Co. Ltd., Vancouver, B. C.
Mearns, W. C., British Columbia Electric Co., Victoria, B. C.

CAPITAL SECTION

Associate Member:

McNeal, J. A., Westinghouse Electric Corp., Washington, D. C.

CENTRAL NEW YORK CHAPTER

Members:

Killigrew, D. L., Corning Glass Works, Corning, N. Y.
Lawrence, W. H., Gould Farmer Co. Inc., Syracuse, N. Y.
Moyer, M. B., 324 Pearl St., Syracuse, N. Y.
Peckham, C. L., Niagara Mohawk Power Corp., Syracuse, N. Y.

Associate Member:

Bell, C. G., Sylvania Electric Products, Inc., Catenovia, N. Y.

CHICAGO SECTION

Member:

Carlson, L. R., Kraft Foods Co., Chicago, Ill.

Associate Members:

Barr, Stephen, A & R Electric Co., Chicago, Ill.
Bunker, F. M., Public Service Co. of No. Illinois, Harvey, Ill.
Casey, R. R., General Electric Co., Chicago, Ill.
Goddard, E. G., Progressive Products Co. Inc., Chicago, Ill.
Goose, Morton, G & M Electrical Contractors, Chicago, Ill.
Grizaffi, Bernard, Bern Electric Co., Chicago, Ill.
Kamen, William, Main Electric Co., Chicago, Ill.
Lanphar, Oscar, Community Consolidated School Dist. #65, Evanston, Ill.
McFarland, J. M., Commonwealth Edison Co., Chicago, Ill.
Prince, S. H., Commonwealth Edison Co., Chicago, Ill.
Rafel, G. A., G. A. Rafel & Co., Chicago, Ill.
Ribble, J. L., Public Service Co. of No. Ill., Dixon, Ill.
Robinson, J. D., A & R Electric Co., Chicago, Ill.
Snow, P. D., Commonwealth Edison Co., Chicago, Ill.

CLEVELAND SECTION

Member:

Thayer, R. N., General Electric Co., Cleveland, Ohio.

Associate Members:

Hebron, R. L., Westinghouse Electric Corp., Cleveland, Ohio.
Stoffer, E. R., The Union Metal Mfg. Co., Canton, Ohio.
Terry, Leonard, Westinghouse Electric Corp., Cleveland, Ohio.
Waite, R. W., Case Institute of Technology, Cleveland, Ohio.

(Continued on page 55A)

IT'S EASY TO SEE WHEN IT'S SUNBEAM LIGHTING

Yes, it's easy to see why Sunbeam visionaires lead the field in integrated design and photometric characteristics. They are all designed to produce better lighting for better vision.

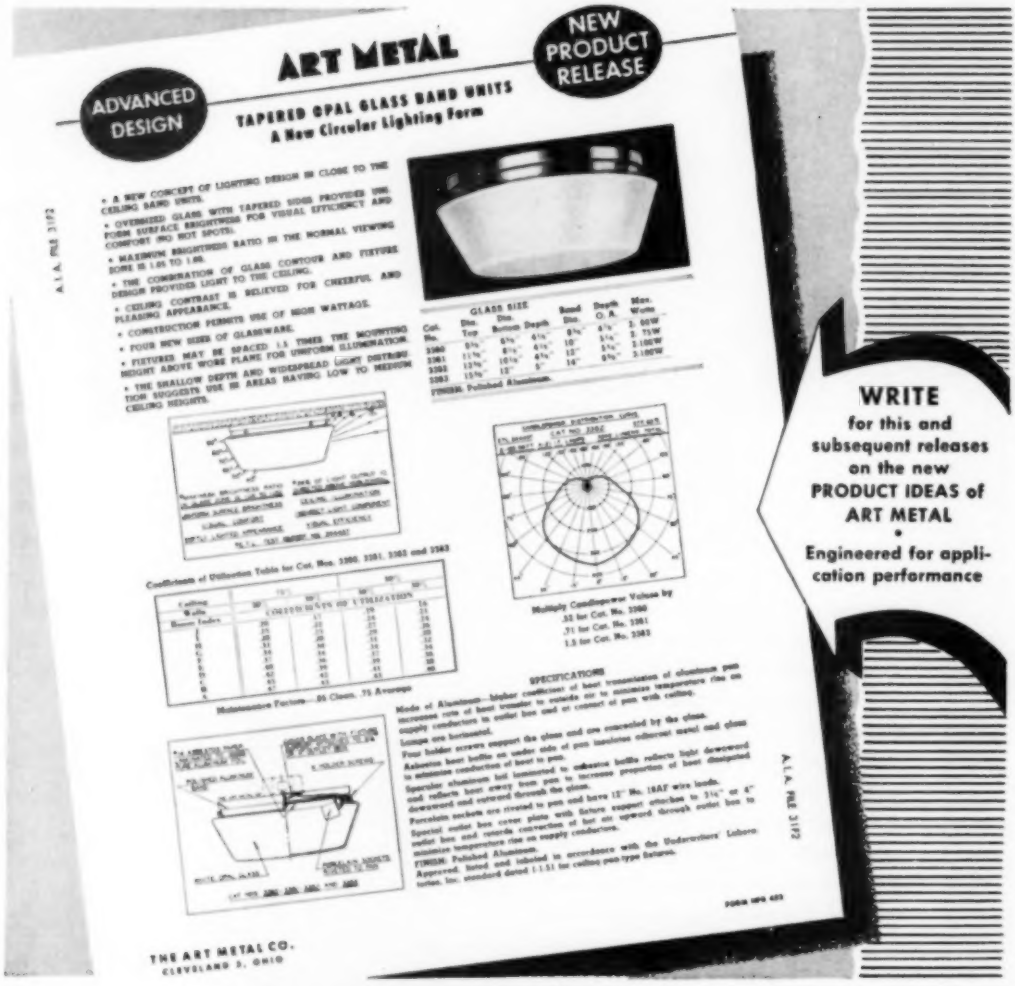
It's easy to see why Sunbeam is specified more and more. Architects value the sturdy, precision-made fixtures which incorporate many features for minimum maintenance and easy installation. Typical of Sunbeam's newer designs are the P1273 series, a unique 3-lamp luminous-indirect type, L1280 series of which many thousands have been installed throughout the country, and the versatile L1710 series which may be installed in pattern arrangements.

See these, and many other advanced fixtures at our booth in the 4th International Lighting Exposition at Cleveland, May 6th to 9th, 1952.

SUNBEAM

LIGHTING COMPANY • 777 EAST 14TH PLACE
LOS ANGELES 21, CALIFORNIA

An ART METAL Original Design in INCANDESCENT LIGHTING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SUSTAINING MEMBERS

Acme Electric Corp.
Cuba, N. Y. *J. A. Comstock*

Advance Electrical Supply Co.
2033 W. Madison, Chicago, Ill. *Lee Butler*

Alabama Power Co.
Birmingham, Ala. *George L. Morris*

All Bright Electric Products Co.
3917-25 N. Kedzie Ave.,Chicago 18, Ill.
Max Klein

Aluminum Company of America
Gulf Building, Pittsburgh 19, Pa. *C. Braglio*

Amalgamated Electric Corp., Ltd.
384 Pape Ave., Toronto, Ont., Canada
W. A. Balrymple

American Concrete Corp.
5092 N. Kimberly Ave., Chicago 30, Ill.
J. W. Lewis

American Fluorescent Corp.
5407 Broadway, Chicago, Ill. *William Rusnak*

American Steel and Iron Works
5801 South Lowe Ave., Chicago 21, Ill.
Walter H. Krueger

American Sterilizer Co.
Erie, Pa. *Horace Wm. Alexander*

Appleton Electric Co.
1701-1729 Wellington Ave., Chicago 13, Ill.
Nils A. Tornblom

Arkansas Power & Light Co.
Simmons National Bldg., Pine Bluff, Ark.
Max Sudduth

The Art Metal Co.
1814 E. 40th St., Cleveland 3, Ohio
George E. Glatthar

Atlantic City Electric Co.
1600 Pacific Ave., Atlantic City, N. J.
John B. Taylor

M. B. Austin Co.
1405 Shermer Ave., Northbrook, Ill.
James M. Collins

Bausch & Lomb Optical Co.
Rochester 2, N. Y. *Arthur E. Neumer*

Benjamin Electric Mfg. Co.
Des Plaines, Ill. *Benjamin S. Benson*

Blue Ridge Glass Corp.
P.O. Box 651, Kingsport, Tenn. *James Herbert*

Board of Water and Electric Light Commissioners
116 W. Ottawa St., P.O. Box 570, Lansing 3, Mich. *John D. Malnight*

Boston Edison Co.
39 Boylston St., Boston 12, Mass. *R. B. Brown, Jr.*

Branham, Marecek & Duepner, Inc.
7020 Walker St., St. Louis Park, Minneapolis 16, Minn. *Cecil H. Branham*

Bright Light Reflector Co., Inc.
Fairfield & State, Bridgeport 5, Conn. *R. J. Mott*

British Columbia Electric Rwy. Co., Ltd.
570 Dunsmuir St., Vancouver, B. C., Canada
H. N. Walters

Brockton Edison Co.
36 Main St., Brockton 67, Mass. *W. A. Forbush*

Edward F. Caldwell & Co., Inc.
101 Park Ave., New York 17, N. Y. *E. T. Caldwell*

California Electric Power Co.
P.O. Box 512, Riverside, Calif. *Robert W. Dowd*

Calpa Products Co.
4116 Chester Ave., Philadelphia 4, Pa.
Paul C. Calisi

Cambridge Electric Light Co.
46 Blackstone St., Cambridge 39, Mass.
Reginald H. Bowman

Canadian General Elec. Co., Ltd.
212 King St., Toronto, Ont. *R. M. Love*

Canadian Laco Lamps, Ltd.
745 Guy St., Montreal, Que. *J. Thomas*

Canadian Line Materials, Ltd.
Postal Station H, Toronto 13, Ont., Canada
L. E. Messinger

Central Hudson Gas and Elec. Corp.
50 Market St., Poughkeepsie, N. Y. *H. E. Dexter*

Central Illinois Light Co.
316 Jefferson Ave. S., Peoria 2, Ill.
W. J. Tometich

Central Illinois Public Service Co.
607 E. Adams St., Springfield, Ill. *B. L. Palm*

Central Maine Power Co.
9 Green St., Augusta, Maine *Roland W. Hess*

Central Power & Light Co.
P.O. Box 2121, Corpus Christi, Texas
James M. Williams

Champion Lamp Works Div. of Consolidated Electric Lamp Co.
600 Broad St., Lynn, Mass. *Ellery H. Raddin*

Cincinnati Gas & Electric Co.
Fourth & Main Sts., Cincinnati 1, Ohio
J. R. Hartman

City of Burbank, California Public Service Dept.
174 W. Magnolia Boulevard, Burbank, Calif.
J. H. McCambridge

City of Glendale Public Service Dept.
119 N. Glendale Ave., Glendale 6, Calif.
L. W. Grayson

City of Riverside Electric Light Dept.
3854 Mulberry St., Riverside, Calif.
L. W. Grayson

City of Seattle, Dept. of Lighting—Puget Sound
1015 Third Ave., Seattle 4, Wash. *P. C. Stewart*

City of Tacoma, Light Division
402 City Hall, Tacoma 2, Wash. *Roy H. Weston*

The Cleveland Electric Illuminating Co.
75 Public Square, Cleveland 1, Ohio
R. C. Hienton

Clyde Porcelain Steel Corp.
2211 Birdseye St., Clyde, Ohio *W. F. White*

Colonial Premier Corp.
466 W. Superior St., Chicago 10, Ill.
Richard Weis

Columbia Electric & Mfg. Co.
1024 West Ide Ave., Spokane, Wash.
Walter A. Toly

Commercial Light Co.
841 W. Washington Blvd., Chicago, Ill.
Michael R. Fine

Commonwealth Edison Co.
72 W. Adams St., Chicago 90, Ill.
Ralph G. Raymond

The Connecticut Light & Power Co.
250 Freight St., Waterbury 91, Conn.
Robert G. Ely

Consolidated Edison Co. of N. Y., Inc.
4 Irving Place, New York 3, N. Y. *C. Miller*

Consolidated Gas, Elec. Light & Power Co. of Baltimore
100 W. Lexington St.,Baltimore 1, Md.
M. C. Albrittain

Consumers Power Co.
212 Michigan Ave. W., Jackson, Mich. *D. E. Karn*

Consumers Public Power Co.
1452 25th Ave., Columbus, Nebr. *W. H. Sinke*

Corning Glass Works
Corning, N. Y. *A. S. Tyler*

Continental Electrical Construction Co.
5540 Southport Ave., Chicago 13, Ill.
Leo W. Wilts

Coyne Electrical School, Inc.
500 So. Paulina St., Chicago 7, Ill. *John Hanan*

Crescent Electric Supply Co.
765 Iowa St., Dubuque, Iowa *Titus B. Schmid*

Crouse-Hinds Co.
Syracuse 1, N. Y. *A. H. Clarke*

Crouse Hinds Co. of Canada, Ltd.
7 Labatt Ave., Toronto, Ont. *F. R. Jeffery*

Curtis Lighting, Inc.
6135 W. 65th St., Clearing Station, Chicago 38, Ill. *Darwin Curtis*

Curtis Lighting of Canada, Ltd.
195 Wicksteed Ave.,Leaside, Toronto 12, Ont.
H. L. Wright

Cutler Light Manufacturing Co.
2026-28 N. 22d St., Philadelphia 21, Pa.
Robert T. Cutler

Dallas Power & Light Co.
1506 Commerce St., Dallas 1, Texas *W. G. Moore*

Day-Brite Lighting, Inc.
5401 Bulwer St., St. Louis 7, Mo. *D. J. Biller*

The Dayton Power & Light Co.
25 No. Main St., Dayton, Ohio *H. S. Nonneman*

Dazor Manufacturing Corp.
4485 Duncan Ave., St. Louis 10, Mo. *P. L. Read*

Delaware Power & Light Co.
600 Market St., Wilmington 99, Del.
W. A. F. Pyle

Dept. of Water & Power, City of Los Angeles, Bur. of Power & Light
Box 3669, Terminal Annex, 207 So. Broadway, Los Angeles 54, Calif. *C. P. Garman*

Detroit Edison Co.
2000 Second Ave., Detroit 26, Mich. *L. E. Tayler*

Detroit Electrical Contractors Association
627-628 Hotel Book Cadillac, Detroit 26, Mich.
Carl J. Schorniger

Detroit Steel Products Co.
2250 E. Grand Blvd., Detroit 11, Mich.
W. Clifton Randall

E. I. duPont de Nemours & Co., Inc. (Fabrics & Finishes Div.)
Wilmington 98, Del. *S. W. Quisenberry*

E. I. duPont de Nemours & Co., Inc. Polychemicals Dept.
Wilmington 98, Del. *R. E. Leary*

Duquesne Light Co.
435 Sixth Ave., Pittsburgh 19, Pa. *G. W. Ousler*

Duro Test Corp.
2321 Hudson Blvd., North Bergen, N. J.
James L. Cox

Eastern Fixture Co., Inc.
170 Vernon St., Boston 20, Mass. *Louis Gilman*

(*Continued on page 32A*)

(*Note:* Names of Official Representatives appear in italics.)

(Continued from page 31A)

East Side Metal Spinning & Stamping Corp.
1501 Elizabeth Ave., W., Linden, N. J.
M. A. Kremer

Ebasco Services, Inc.
2 Rector St.,New York 6, N. Y. *M. E. Stone*

Efongeo Electrical Supply Co.
949 W. Chicago Ave., Chicago 22, Ill. *Lee Mirus*

Electrical Information Publications, Inc.
20 N. Carroll St., Madison, Wis. *Lewis E. Johnson*

Electrical Testing Laboratories, Inc.
79th St. & East End Ave., New York 21, N. Y.
W. F. Little

Electric Supply Corporation
701 W. Jackson Blvd., Chicago 6, Ill.
G. M. Marks

Electro Manufacturing Corp.
2000 W. Fulton St., Chicago 12, Ill.
L. K. Schoenbrod

Electrolier Mfg. Company, Ltd.
5849 Boyer St., Montreal, Que., Canada
John Issenman

Electron Corp.
5100 South Santa Fe, Littleton, Colo.
Milt Heisner

Englewood Electrical Supply Co.
5801-03 So. Halsted St., Chicago, Ill. *Ray O'Leary*

Fitchburg Gas & Electric Light Co.
537 Main St., Fitchburg, Mass. *A. G. Neal*

Florida Power & Light Co.
Box 3100, Miami 30, Fla. *C. B. Fick*

Fluorescent Equipment & Mfg. Co.
2570 Superior Ave., Cleveland 14, Ohio
Leonard S. Freeman

Fluorescent Fixtures of Calif.
[illegible] 16th St., San Francisco 10, Calif.
Ernst O. Anders

Fluores-O-Lite Co.
Evans Terminal, No. Broad St., Hillside, N. J.
Meyer H. Silverman

The Fostoria Pressed Steel Corp.
Fostoria, Ohio *E. L. Bates*

H. A. Fromburg & Co.
3920-28 Carroll Ave., Chicago 24, Ill.
Stanley A. Fromburg

The Franco Mfg. Co.
10325 Berea Rd., Cleveland 2, Ohio *J. H. Mayne*

The Frankelite Co.
1425 Rockwell Ave., Cleveland 14, Ohio
Dave Frankel

Franklin Design Service, Division of Safeway Stores, Inc.
4th & Jackson Sts., P.O. Box 660, Oakland 4, Calif.
T. E. Rhinehart

The Frink Corporation
27-01 Bridge Plaza North, Long Island City, N. Y.
Theo. J. Brassel, Jr.

Fullerton Manufacturing Corp.
17 Chestnut St., South Norwalk, Conn.
Lawson Fullerton

Gallagher-O'Brien Electric Co., Inc.
915 W. North Ave., Chicago 22, Ill.
Frank A. Gallagher

Garden City Plating & Mfg. Co.
1750 No. Ashland Ave., Chicago 22, Ill.
G. G. Harney

General Electric Co., Apparatus Dept.
River Works, 920 Western Ave., West Lynn, Mass.
A. F. Dickerson

General Electric Co., Lamp Dept.
Nela Park, Cleveland 12, Ohio *Willard C. Brown*

General Electric Supply Corp.
1260 Boston Ave., Bridgeport, Conn.
W. W. Booth

General Lighting Products Co.
468 Frelinghuysen Ave., Newark 5, N. J.
Nathan H. Eglowstein

General Outdoor Advertising Co., Inc.
515 So. Loomis St., Chicago, Ill. *R. E. Nevios*

The Georgia Power Co.
Electric Building, Atlanta 1, Ga.
Charles A. Collier

Gibson Manufacturing Co.
1919 Piedmont Circle N. E., Atlanta, Ga.
R. R. Gibson

Gill Glass & Fixture Co.
Amber & Tioga Sts., Philadelphia 34, Pa.
C. A. Gill

Gillinder Brothers, Inc.
Erie & Liberty Sts., Port Jervis, N. Y.
J. Fletcher Gillinder

Gleason-Tiebout Glass Co.
59-50 54th St., Maspeth, N. Y.
Marshall T. Gleason

Globe Lighting Products Co., Inc.
1710 Flushing Avenue, Brooklyn 6, N. Y.
Isidor Rosenblatt

Godfrey and Wing, Inc.
2110 Superior Ave., Cleveland 14, Ohio
C. G. Wing

Golde Manufacturing Co.
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Grand Rapids Store Equip. Co.
1540 Monroe Ave., N. W.,Grand Rapids 2, Mich.
Kenneth C. Welch

Graybar Electric Co., Inc.
420 Lexington Ave., New York 17, N. Y.
Raymond C. Kinney

Grayco Products
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Great Northern Mfg. Corp.
4221 W. Harrison St., Chicago 24, Ill. *D. J. Epp*

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301 Lake St., Oak Park, Ill. *W. S. Akely*

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Box 2951, Beaumont, Texas *Clarence Barron*

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Fred E. Guth

The Hankins Container Co.
3044 W. 106th St., Cleveland 11, Ohio
Ray T. White

Hartford Electric Light Co.
266 Pearl St., Hartford 3, Conn. *Victor Ouellette*

Harvstone Manufacturing Co.
542 E. 75th St., Chicago 19, Ill. *A. M. Rishind*

Hawkins Electric Co.
1447 Washington Blvd., Chicago 7, Ill. *R. R. Hill*

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Joseph T. Manuccia

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H. E. Ingraham

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6820 Romaine St., Hollywood 38, Calif.
Edward Meyer

Holophane Company, Inc.
342 Madison Ave., New York 17, N. Y.
H. L. Logan

Home Light and Power Co.
810 Ninth St., Greeley, Colo. *C. Gilbert Dressor*

House-O-Lite Corporation
2430 S. Ashland Ave., Chicago 8, Ill.
Jack R. Stone

Houston Lighting & Power Co.
P.O. Box 1700, Houston 1, Texas *W. J. Aichlen*

Hub Electric Company
2219 W. Grand Ave., Chicago 12, Ill.
I. M. Fixman

Hydro-Electric Power Comm. of Ont.
620 University Ave., Toronto, Ontario
R. L. Hearn

Hyland Electrical Supply Co.
700 West Jackson Blvd., Chicago, Ill. *J. A. Tills*

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134 East Main St., (L Box 511 B), Decatur 70, Ill. *Allen Van Wyck*

Illuminating Engineering Co.
2347 E. Nine Mile Road, Hazel Park, Mich.
Bert C. Pretzer

Interstate Power Company
1000 Main St., Dubuque, Ia. *P. H. Brown*

Iowa Electric Light & Power Co.
Box 351, Cedar Rapids, Iowa *Sutherland Dour*

Iowa-Illinois Gas & Electric Co.
United Light Bldg., Davenport, Iowa
John M. Hollingsworth

Iowa Power and Light Co.
312 Sixth Ave., Des Moines 3, Iowa
N. Bernard Gussett

Iowa Public Service Co., East Div.
400 Commercial St., Waterloo, Iowa
C. R. Wagoner

Iowa Public Service Co., Sioux City Division
P.O. Box 778, Sioux City 4, Iowa *C. R. Tracy*

Jefferson Electric Co.
Bellwood, Ill. *L. Mauerer*

Jersey Central Power & Light Co.
501 Grand Ave., Asbury Park, N. J. *D. J. Douglas*

Joleco Corporation
2513 Baldwin St., St. Louis, Mo. *George Ledbetter*

Jones Metal Products Co.
West Lafayette, Ohio *H. Boyer*

Joslyn Mfg. & Supply Co.
3700 So. Morgan St., Chicago 9, Ill. *J. H. Fahey*

Kansas City Power & Light Co.
P.O. Box 679, Kansas City 10, Mo.
John M. Arthur, Jr.

Kansas Gas & Electric Co.
P.O. Box 204, Wichita, Kans. *H. W. Hobson*

The Kayline Company
2480 E. 22d St., Cleveland 15, Ohio *M. A. Eskins*

Kelso-Burnett Electric Co.
225 W. Jackson Blvd., Chicago 6, Ill.
Sigmund A. Hollinger

Kerrigan Iron Works, Inc.
1035 Herman St., Nashville,Tenn. *G. E. Daniels*

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Leonard M. Siegel

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3435 E. Jefferson Ave., Detroit 7, Mich.
Ivan Kirlin

Kopp Glass, Inc.
Swissvale, Pa. *F. C. Ashe*

The La Salle Lighting Products, Inc.
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Richard C. Piper, Jr.

Leador Electric Manufacturing Corp.
3500 N. Kedzie St., Chicago 18, Ill. *Walter Glass*

The Leeds & Northrup Co.
4901 Stenton Ave., Philadelphia 44, Pa.
I. M. Stein

Libbey-Owens-Ford Glass Co., Plaskon Division
2112-24 Sylvan Ave., Toledo, Ohio
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(Continued on page 35A)

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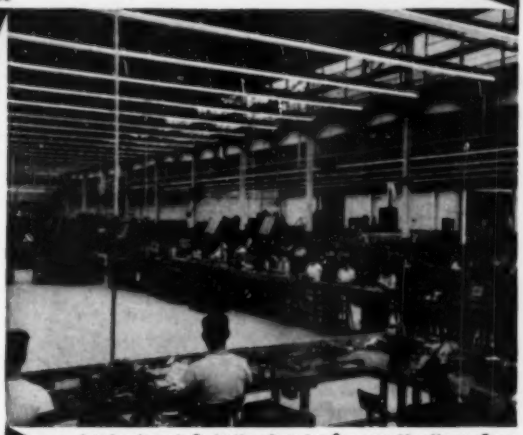

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Lithonia, Georgia *Robert J. Freeman*

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Luminator, Inc.
120 N. Peoria St., Chicago 7, Ill.
Albert L. Arenberg

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Markel Electric Products, Inc.
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Morris L. Markel

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Nathan Bloom

Metal Window Institute
Cheltenham, Pa. *George Hingston*

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2525 Clybourn Ave., Chicago 14, Ill.
Bernard Mitchell

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19 Waterman Ave., Toronto 13, Ont.
J. E. Landers

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7809 Maplewood Industrial Court,
Maplewood 17, Mo. *J. E. Baker*

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M. L. Offenberg

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1415 Illinois Ave., Sheboygan, Wis. *M. B. Deutsch*

Moe Light, Inc.
700 Oak St., Fort Atkinson, Wis. *Stanley Warner*

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831 Second Ave. So., Minneapolis 2, Minn.
W. L. Hayes

Municipal Light and Power Dept.
City of Pasadena, California, 302 City Hall,
Pasadena 1, Calif. *E. L. Bettannier*

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Earle C. Edwards

Niagara Mohawk Power Corp.
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Northern Electric Co. Ltd.
1620 Notre Dame St., West, Montreal, Quebec
P. P. Labey

Northern Indiana Public Service Co.
5265 Hohman Ave., Hammond, Ind.
J. C. Sackman

Northern Light Company
1657 No. Water St., Milwaukee 2, Wis.
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720 Electric Bldg., Omaha 2, Nebraska
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C. A. Root

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L. A. Van Dusen

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P. G. Dingledy

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1457 E. 40th St., Cleveland, Ohio
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R. G. Rhincliffe

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H. C. Zimmeister

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Electric Bldg., Portland 5, Ore. *T. W. Fitch*

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M. B. Hastings

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G. O. Stewart

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Dwight E. Worrell

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Reuben Huberman

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Paul E. Poitras

Quebec Power Co.
229 St. Joseph St., Quebec, Que.
Jean Saint-Jacques

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Edward Rambusch

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Van N. Marker

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Arthur Peterson

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89 East Ave., Rochester 4, N. Y. *L. C. Twitchell*

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Nyack, N. Y. *D. S. Schaab*

Rohm and Haas Co.
222 W. Washington Sq., Philadelphia 5, Pa.
W. T. Reedy

Ruby Lighting Corp.
1212 S. Olive St., Los Angeles 15, Calif.
Albert Jassim

(Continued on page 36A)

(Continued from page 35A)

Ruby-Philite Corp.
32-02 Queens Blvd., Long Island City 1, N. Y.
Louis Phillips

Rumsey Electric Co.
1007 Arch St., Philadelphia 7, Pa. *T. W. Lauer*

Ryall Electric Supply Co.
1160 Stout, Denver, Colo. *C. O. Ryall*

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Sandol Manufacturing Co.
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Savannah, Ga. *J. L. Davidson*

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Louis Rosenstein

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Chas. H. Talbot

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101 Prospect Ave., N. W., Cleveland 1, Ohio
J. A. Meacham

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J. M. Gilbert

Smithcraft Lighting Division
A. L. Smith Iron Company
217 Everett Avenue, Chelsea 50, Mass.
Hugh M. Nasor

Smoot-Holman Co.
921 No. Eucalyptus Ave., Inglewood, Calif.
L. A. Hobbs

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4633 W. 16th St., Chicago 50, Ill. *L. C. Marschall*

Solar Light Mfg. Co.
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280 Faillon St., West, Montreal, Que.
Leon Beauchamp

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601 West 5th St., Los Angeles 53, Calif.
Roy E. Dahlin

Southern Canada Power Co., Ltd.
355 James St., West, Montreal, Que.
George R. Atchinson

Southern Colorado Power Co.
Box 75, Pueblo, Colo. *E. H. Pemberton*

Southern Indiana Gas & Elec. Co.
P.O. Box 569, Evansville 5, Ind. *C. K. Graham*

Southern Lighting Mfg. Co.
P.O. Box 2546, Orlando, Fla. *Max K. Aulich*

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Box 1106, Shreveport, La. *J. E. Elliott*

Southwestern Public Service Co.
Amarillo, Texas *J. E. Cunningham*

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Bernard S. Heller

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2700 Roosevelt Rd., Broadview, Maywood, Ill.
Robert J. Besal

Steiner Electric Co.
3500 Milwaukee Ave., Chicago 41, Ill.
George S. Steiner

Sterling Reflector & Mfg. Co.
5249 West Grand Ave., Chicago 51, Ill.
Anton Oberhuber

Stonco Electric Products Co.
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2555 Bellevue Ave., Detroit 7, Mich. *Fred Binder*

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Jerome Gimbel

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Cass & Tampa Sts., Tampa 1, Fla. *F. J. Gannon*

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Harold C. Smith

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Elmer L. Torstenson

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Triangle Industries
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Robert A. Stott

Tru-Lite Ltd.
624 Notre Dame St., W., Montreal, Que.
Omer M. Trudel

Underwriters' Laboratories, Inc.
207 E. Ohio St., Chicago 11, Ill. *Ferd. Neumer*

Union Electric Co. of Missouri
12th & Locust Sts., St. Louis 1, Mo. *W. L. Berry*

Union Metal Mfg. Co.
Canton 5, Ohio *W. A. Porterfield*

Unistrut Corp.
4118 Monroe Ave., Wayne, Mich.
James W. Attwood

Unistrut Products Company
1015 West Washington Blvd., Chicago 7, Ill.
George W. Butler

The United Illuminating Co.
80 Temple St., New Haven 6, Conn. *E. B. Haskell*

United Manufacturing Co.
Div. United Advertising Corp.
190 Whalley Ave., New Haven, Conn.
William R. Harris

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Box 899, Salt Lake City 10, Utah *W. A. Huckins*

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6009-6103 Longfellow Ave., Cleveland 3, Ohio
W. G. Sawyer

John C. Virden, Ltd.
19 Curity Ave., Toronto, Ont. *P. G. Kirkpatrick*

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Richmond, Va. *J. G. Holtsclaw*

Voigt Co.
1649 No. Broad St., Philadelphia 22, Pa.
C. J. Frank

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Vermilion, Ohio *A. F. Wakefield*

Warren Electric Co.
P.O. Box 2594, Houston, Texas *J. R. Thompson*

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87 Fawcett St., Cambridge, Mass.
Selig M. Friedberg

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P.O. Drawer 1445, Spokane 6, Wash.
Carl L. Hoffman

The Watson Standard Co.
225 Galveston Ave., Pittsburgh 12, Pa.
H. E. Striker

Welsbach Engineering and Management Corp.
1500 Walnut St., Philadelphia 2, Pa. *H. H. Adams*

Westinghouse Electric Corp.
1216 W. 58th St., Cleveland 1, Ohio
(P. O. Box 5817) *Burt S. Burke*

Westinghouse Electric Supply Co.
113 North May St., Chicago 7, Ill. *Henry Czech*

Westinghouse Lamp Div.
Bloomfield, N. J. *Samuel G. Hibben*

West Penn Power Co.
14 Wood St., Pittsburgh 30, Pa. *Harry Rastofski*

Wheeler Reflector Co.
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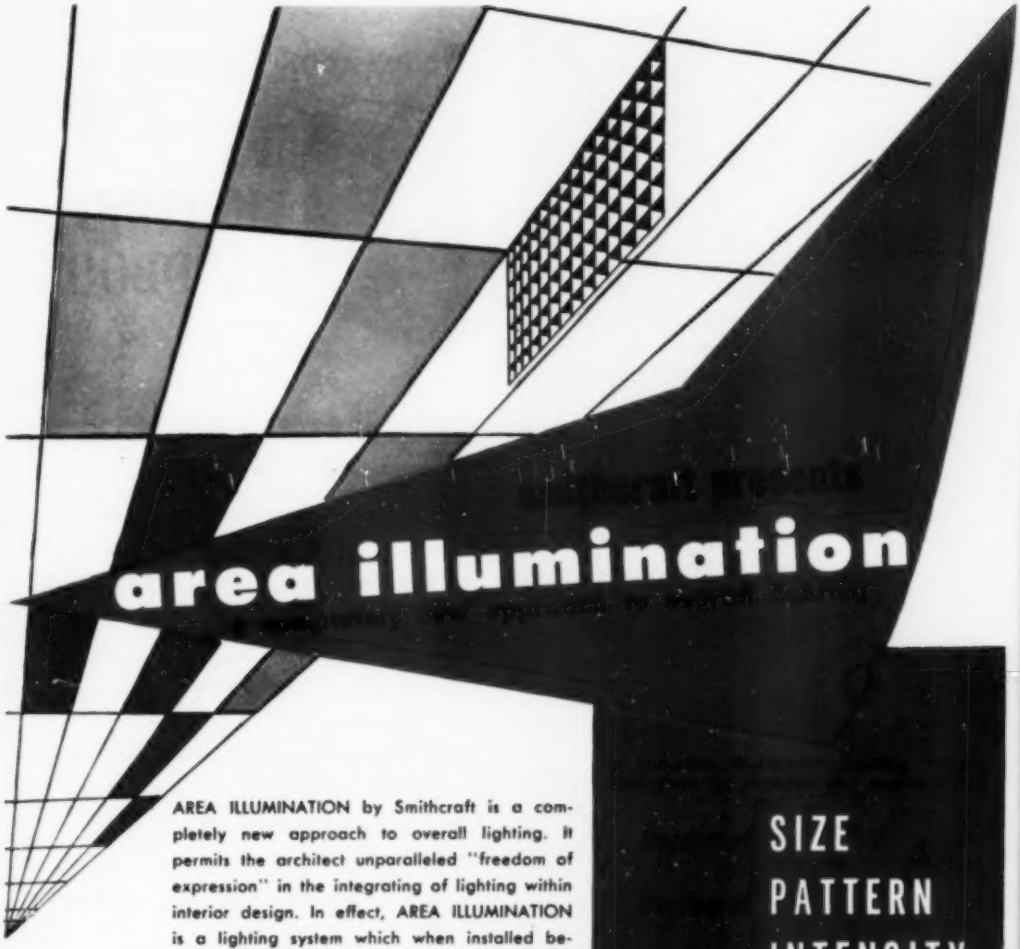

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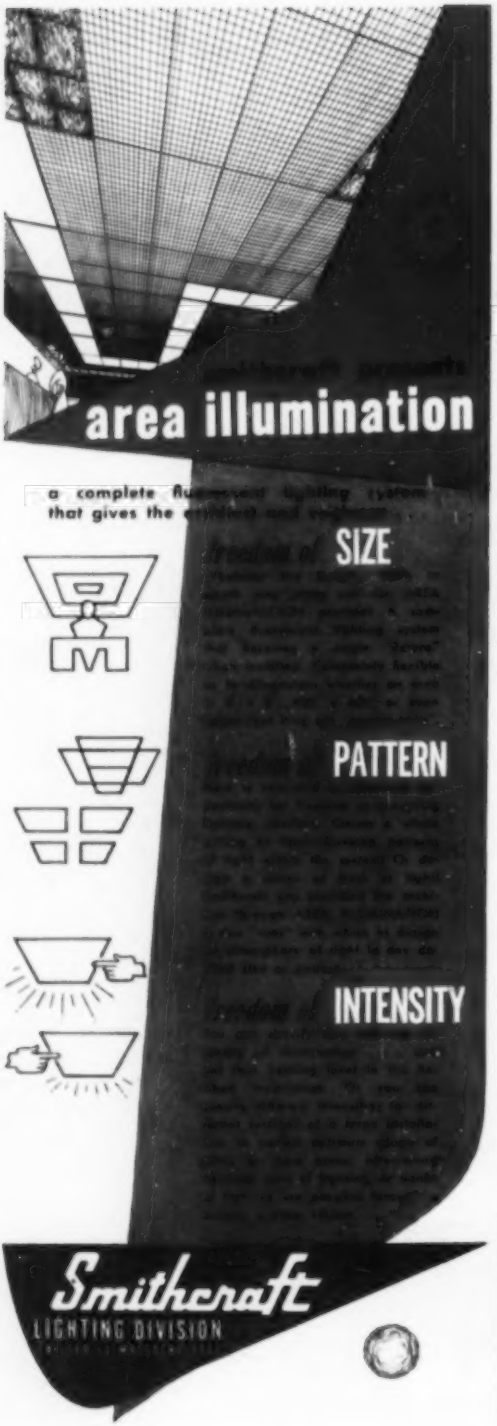

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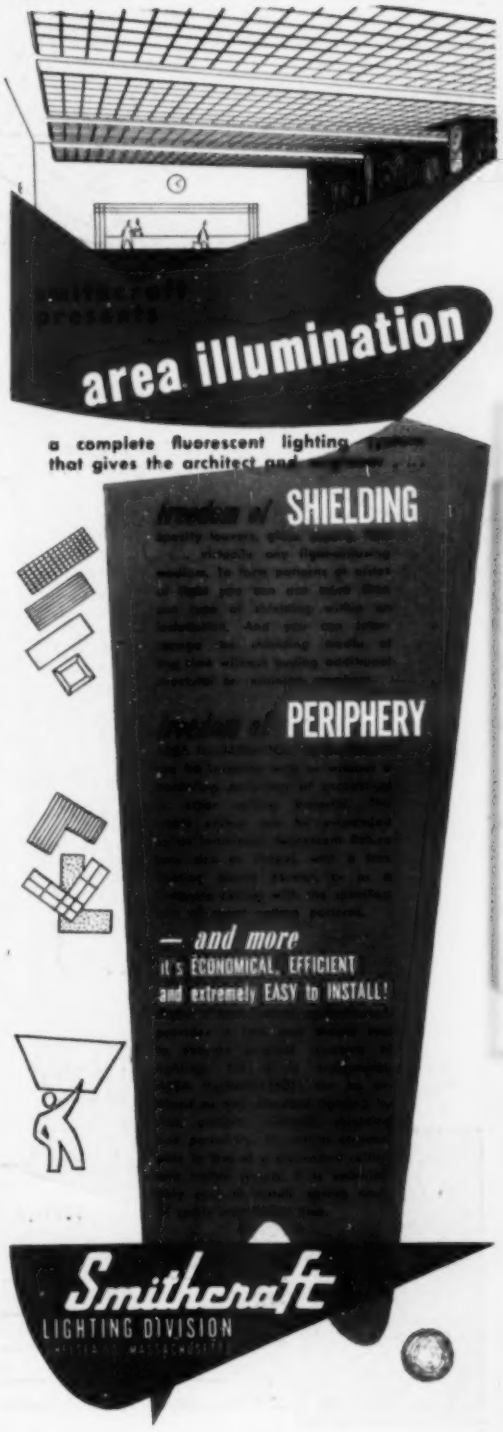

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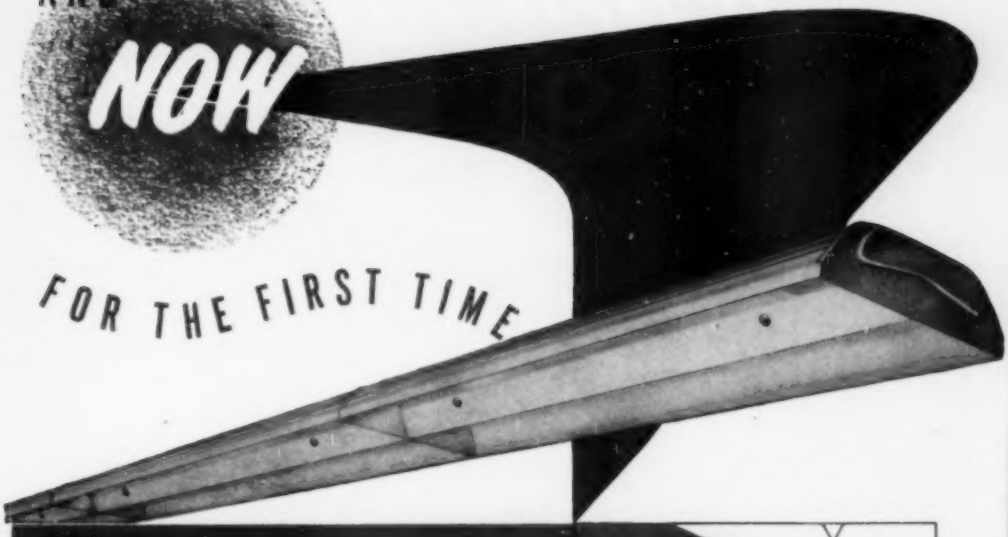

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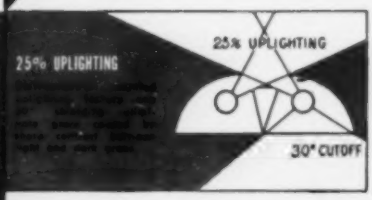

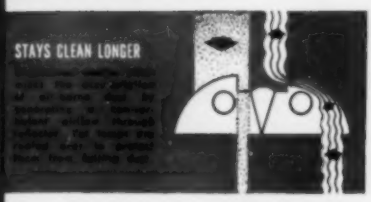

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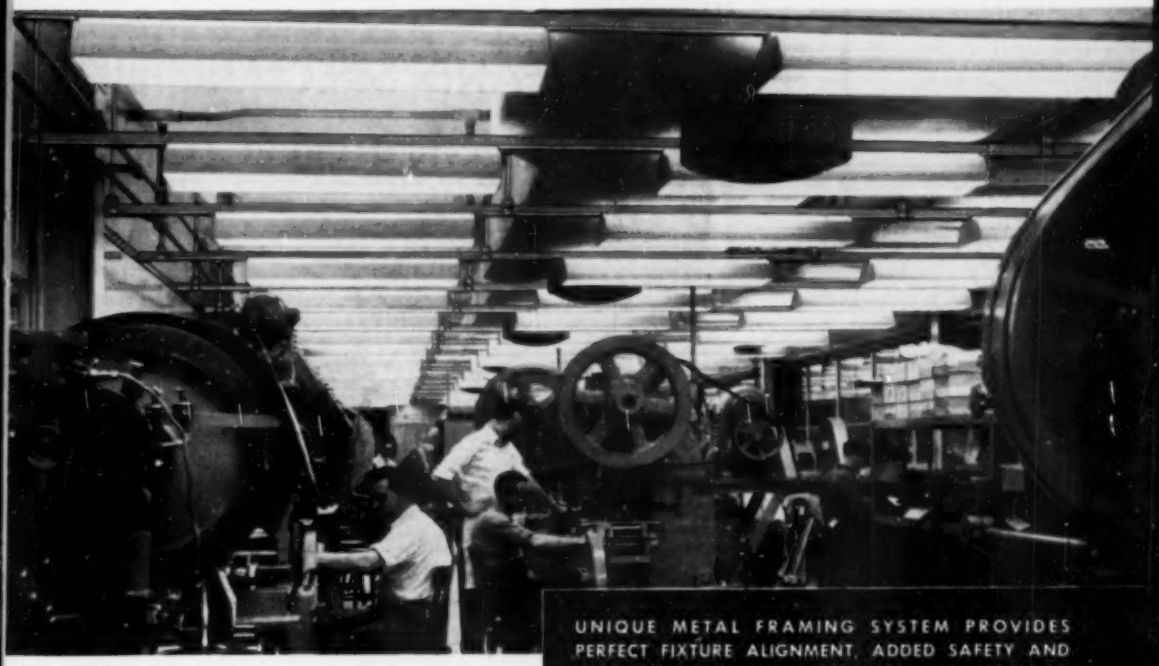

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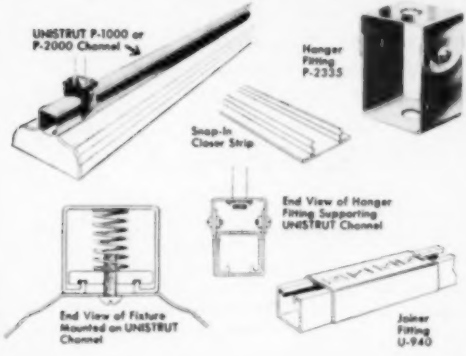
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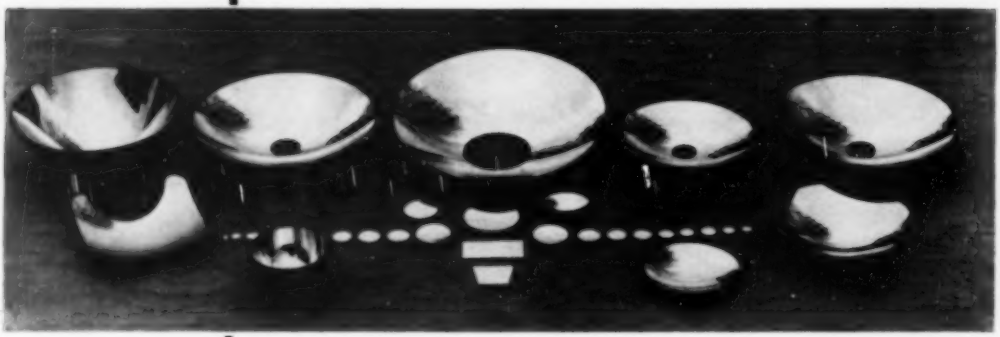

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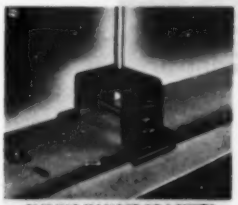

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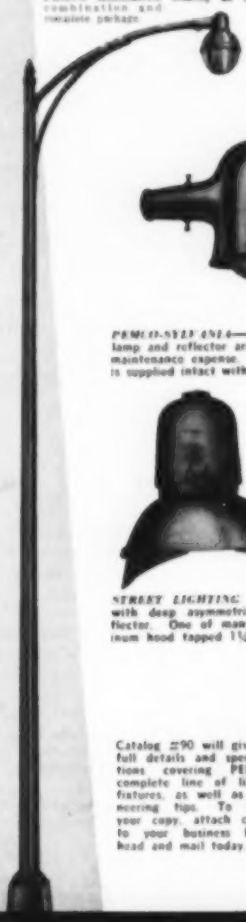

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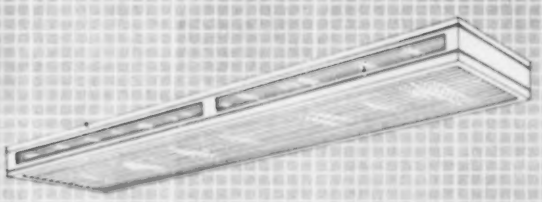

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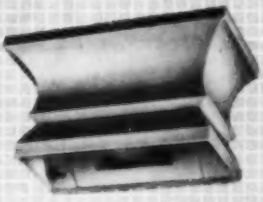

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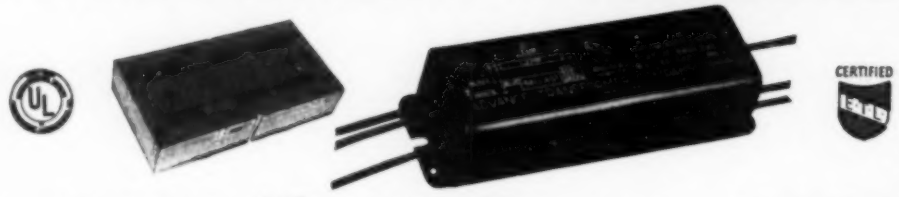

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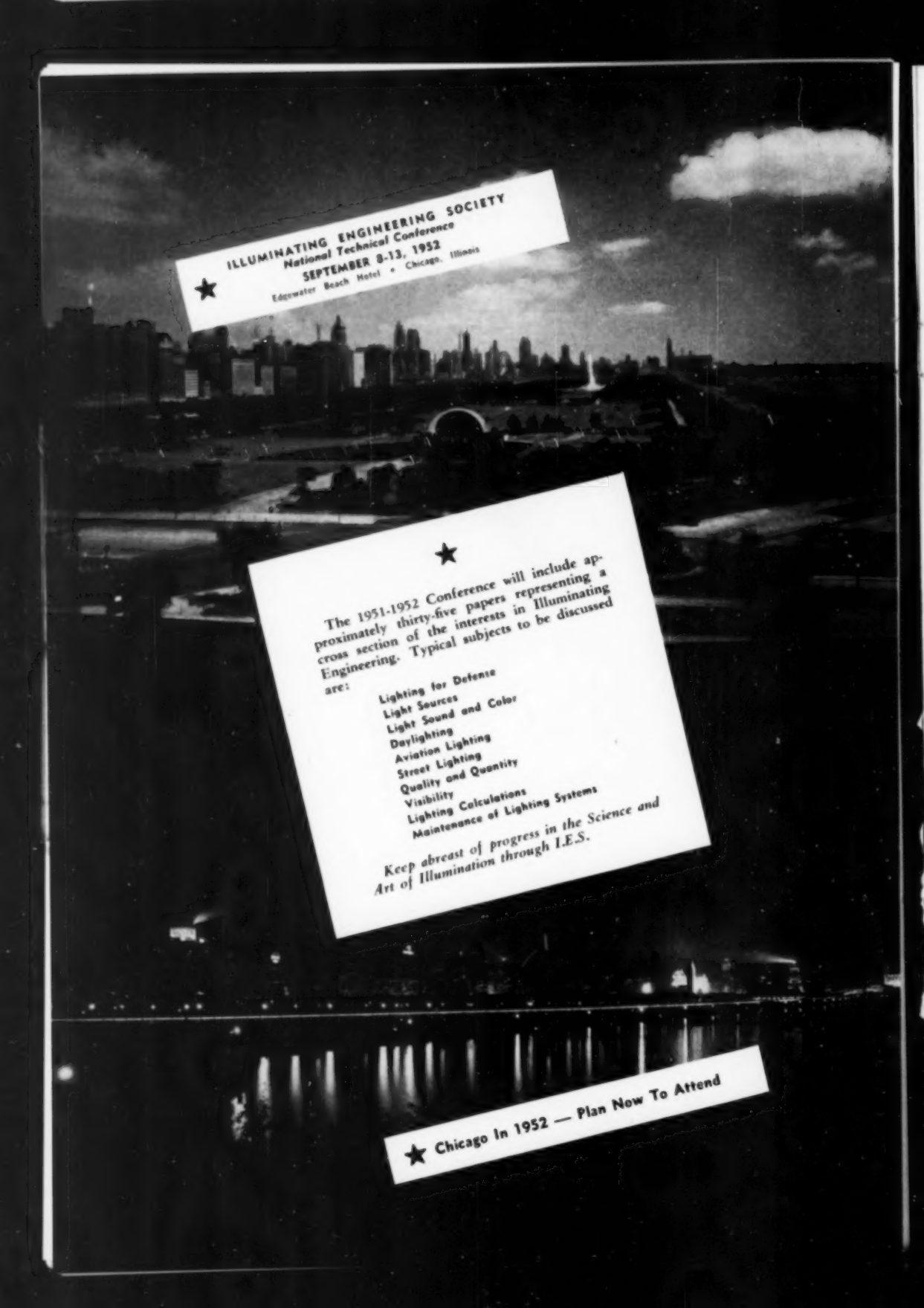
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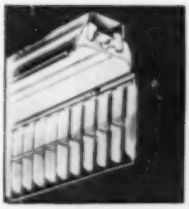

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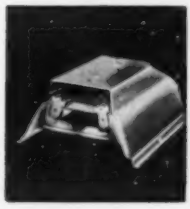

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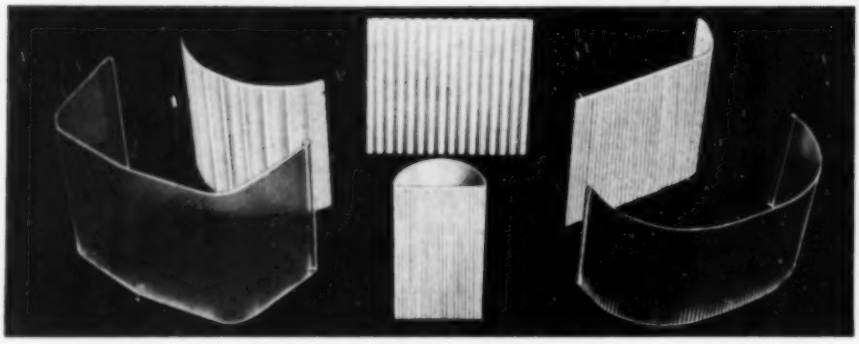

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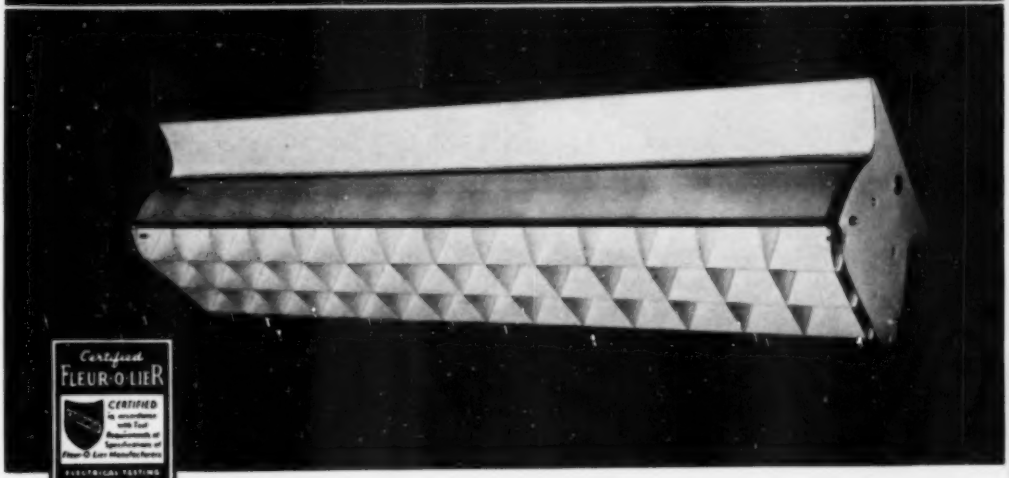

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at the
CLEVELAND
LIGHTING EXPOSITION

See
GILL'S
NEW 900 LINE

Here it is! The new 900 Line . . . softly luminous, semi-direct lighting Luminaire by GILL . . . importantly featuring low brightness. Its many features make it the perfect luminaire for office—stores—schools.

The 900 Line has curved glass side reflectors for unexcelled, uniform brightness, and may be installed directly on the ceiling in individual or continuous row arrangements. If specified, plastic or metal side reflectors can be supplied.

These luminaires provide 45° shielding in both directions, and, even with the extra large louvres for easy cleaning, low brightness is still maintained.

The GILL 900 Line carries the certification of Underwriters Laboratories, Fleur-o-lier, ETL.

Sizes: 2, 3, and 4 lamp, bi-pin fluorescent lamps and/or single pin SLIMLINE lamps in 48" or 96" sizes (lengths).

For full information, fill in coupon and mail us today. A prompt answer is assured.

Gill Glass and Fixture Company
Amber & Tioga Sts., Philadelphia 34, Pa.
Please send information on Gill's new 900 line
Name
Firm
Address Zone State
City

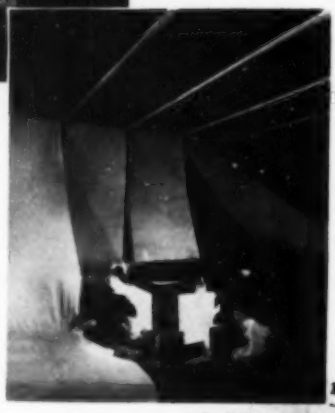
GILL

GILL

GLASS and FIXTURE COMPANY • Amber & Tioga Sts., Phila. 34, Pa.

UNDERWRITERS APPROVED

This Makes LIGHTING HISTORY



So *NEW* that it was too late to make the 4th International Lighting Exposition, but can be seen at . . . .

Cleveland Indians Locker Rooms (Basement of Auditorium)

Public Phone Booths (1st Floor Lobby of Auditorium)

Dean Electric Co. Office, 725 Hamilton Avenue (1 block from Auditorium)

To inquire about territorial distribution or franchise of Acusti-Luminus Ceilings visit us at the Hotel Auditorium Room 1028 across the street from Auditorium

ACUSTI-LUMINUS CEILINGS are now fully tested and approved by Underwriters' Laboratories, Inc. Every piece of "LUMI-PLASTIC" bears Underwriters' Rating Label.

In these tests LUMI-PLASTIC was given four fire tunnel tests, in which a heavy 3 foot flame was introduced in a twenty foot sealed tunnel. LUMI-PLASTIC melted away, and was consumed at the flame. Softening took place past the flame, where condition of corrugated sheet was remarkably normal otherwise. Noxious gas and smoke were noted negligible.

The main tests embraced the actual fire test of completed ceilings under a sprinkler system. In these tests an alcohol fire was started under a complete ACUSTI-LUMINUS CEILING installed in the normal way.

As soon as the heat from the fire reached the "LUMI-PLASTIC" it softened and lost its corrugated stiff structure. Progressively it fell out of place on its supports, and on hitting the flame melted away, and flame did not spread. The entire ceiling dropped out in about 3 minutes. The sprinklers came on in 5½ minutes, with no appreciable time delay, as against normal operation. Thus fire, sprinkler, flame spread, electrical tests were all carefully conducted.

ACUSTI-LUMINUS CEILINGS can be used even under sprinklers with no increase in fire rates.

NO NOISE • NO GLARE
EVEN LIGHT EVERYWHERE!

LUMINOUS CEILINGS, INC.

2500 W. NORTH AVE.
CHICAGO - 47 - ILL.

(Continued from page 28A)

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(Continued on page 59A)

(Photo Courtesy of Curtis Lighting Inc., Chicago, Illinois)

Jefferson Series Sequence
430 M. A. Ballast for two
96T12 Lamps.

UL CERTIFIED ETL

FOR LONGER LAMP LIFE—USE NEW LIGHTER WEIGHT BALLAST

• Maximum wattage delivered to each lamp and lower watt loss result in — longer lamp life — rated lamp output — improved all-round user satisfaction.

The new Jefferson Ballast meets all the requirements of proposed American Standard Association Test Specification C82.1 and C.B.M. Supplement No. 1. It incorporates a unique basic design with traditional Jefferson high uniform quality.

You insure the best results with this new Jefferson 254-511 Ballast.

No hum to bother you. Correct design and precision manufacture eliminate audible hum.

Write for Bulletin 551-11 for complete information.

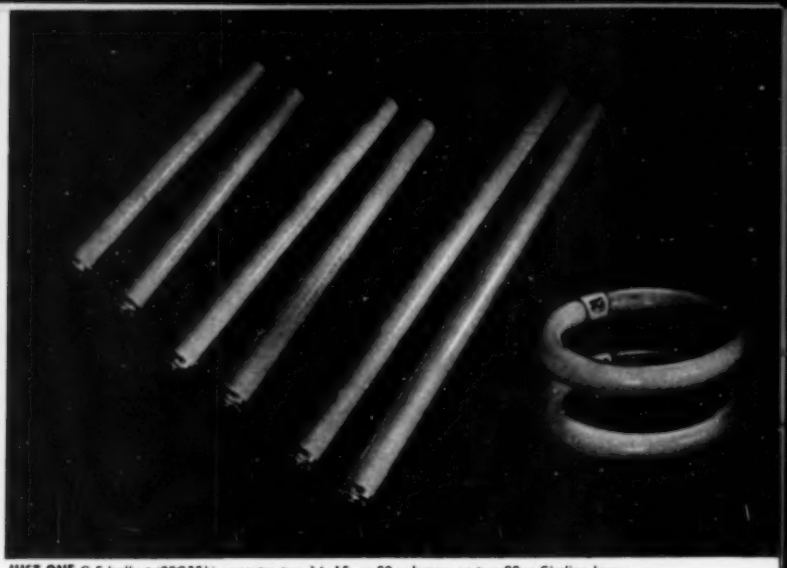
JEFFERSON ELECTRIC COMPANY
Bellwood, Illinois

JEFFERSON ELECTRIC

JEFFERSON
SERIES SEQUENCE
BALLASTS

G-E ballast No. 89G332 for 32-w Circline lamp.

NEW: Ballast 89G322 for 22-w Circline lamp.



JUST ONE G-E ballast (89G331) operates two 14, 15, or 20-w lamps, or two 22-w Circline lamps.

More fixture designs possible

Now—make residential fixtures with all the above lamps and combinations—without using starters!

For the first time you can make fixtures using all of the above lamps and lamp combinations—*without using external starters*—with General Electric's expanded line of Trigger-Start Ballasts!

EXPAND YOUR MARKET

Your fluorescent fixtures will sell easier and faster because of the great customer appeal of G-E Trigger-Start Ballasts. They start lamps instantly without flickering, and they remove the bother of replacing worn-out starters. Moreover, these ballasts conserve lamp life because of their unique operation: electrodes are immediately pre-heated at the flick of the switch, then starting current drops to practically zero when the lamp goes on—almost faster than the eye can see!

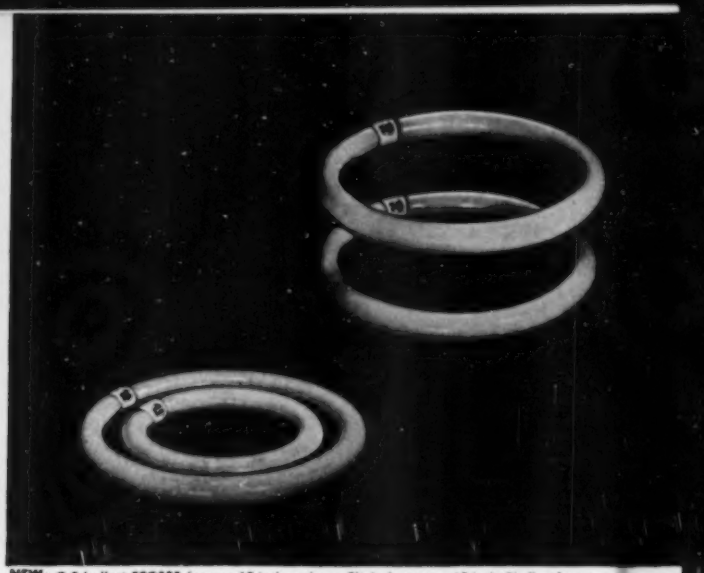
REDUCE STOCK PROBLEMS

Note that only five different G-E Trigger-Start Ballasts are needed to operate all of the above lamps and combinations. And, of course, there's no need to stock starters for trigger-start ballasts.

For more information on G-E Trigger-Start Ballasts contact your local G-E Sales Office, or write *Section 412-98, General Electric Co., Schenectady 5, New York.*

GENERAL ELECTRIC

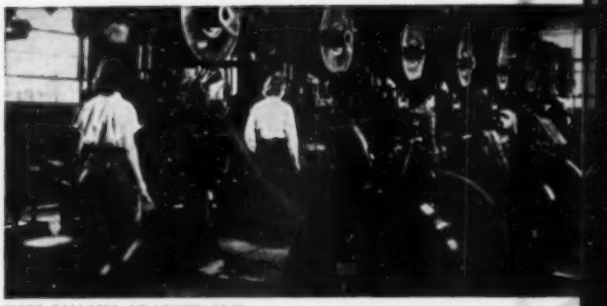
ONE G-E ballast (89G320) for 14, 15, or 20-w lamps.



NEW: G-E ballast 89G333 for one 12-inch and one 8½-inch, or two 12-inch Circline lamps.

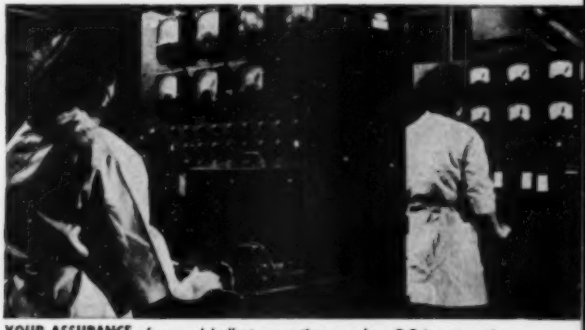
with G-E Trigger-Start Ballasts

BETTER BALLASTS to help you build your fluorescent trade are continually being developed by G.E.—world's largest producer of ballasts. Above, G-E engineers work out new ballast design.



MORE BALLASTS AT LOWER COST are made possible by G-E standardization and mass-production methods. Above are automatic punch presses for cutting core laminations in G-E Danville (Ill.) Plant.

TOP PERFORMANCE is the result of continuing study of fixture manufacturers' problems and actual ballast operation.



YOUR ASSURANCE of a good ballast every time you buy G-E is automatic testing apparatus on the production line.

a LIGHT job* well done

WITH PITTSBURGH PERMAFLECTOR LIGHTING EQUIPMENT

OUTSTANDING! This one word completely describes the illuminating results so easily and successfully achieved at famous Wurzburg, the heart of Grand Rapids. Pittsburgh Permaflector Equipment enabled Wurzburg to plan with imagination and light for their needs. Top performance with "custom designed" appearance was assured. Fluorescent and incandescent units, and combinations of both, meet every lighting requirement.

FOR MORE LIGHTING KNOW-HOW

Write us about lighting installations in stores, offices, banks, buildings or schools. A bulletin covering the job you have in mind will be mailed to you.

PITTSBURGH REFLECTOR COMPANY

411 OLIVER BUILDING • PITTSBURGH 22, PENNSYLVANIA

MANUFACTURER OF FLUORESCENT & INCANDESCENT LIGHTING EQUIPMENT

Permaflector Lighting Engineers in All Principal Cities

PITTSBURGH PERMAFLECTOR LIGHTING EQUIPMENT IS DISTRIBUTED BY "BETTER ELECTRICAL WHOLESALERS EVERYWHERE"

(Continued from page 55A)

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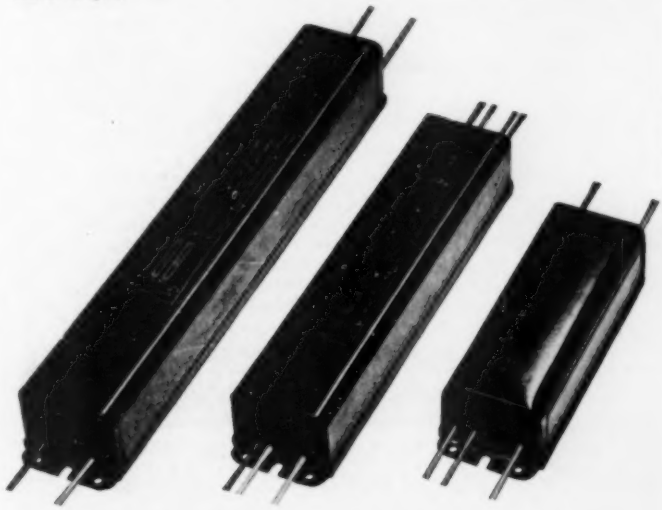
HE SAVED 1/2 to 1% on PRICE BUT LOST 8 8/10% on PERFORMANCE

He thought he had bought a bargain by saving that last ½ of 1% on price and didn't realize he'd penalized himself 8 8/10% on light output. In addition, lamp life was reduced 54% — meaning that lamp replacement and maintenance costs were 100% higher than they need be.

Yes! All this can happen if the ballasts for fluorescent fixtures are economized to price and not engineered to lamp requirements. A 100 watt lamp — needs 100 watt input — 91.2 watts is 8 8/10% short of the need.

Fixture manufacturers using Acme Electric ballasts — need not worry about this problem — all Acme Electric ballasts are properly engineered to their rated output.



ACME ELECTRIC CORPORATION
295 WATER ST. CUBA, N. Y.

Acme ACME Electric
TRANSFORMERS

(Continued from page 59A)

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POWERSTAT
Dimmers
PROVIDE
BIG TIME
LIGHTING CONTROL
ON A SMALL TIME
BUDGET
D1000R
D5000
Modern light dimming equipment need not be expensive. This was conclusively demonstrated by Lawrence Voss, a member of the faculty at Southern Illinois University, when he built a 25,000 watt, preset, proportional dimming, completely flexible, portable switchboard at a materials cost of approximately $1,200. Master dimming is achieved by four 5,000 watt POWERSTAT Dimmers. The flexibility, the consistent performance, the unusual economy of POWERSTAT Dimming Equipment put big time lighting control within the reach of very limited budgets.
THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT
SEND FOR COMPLETE INFORMATION ON
POWERSTAT LIGHT DIMMING EQUIPMENT
Write: 5052 DEMERS AVE., BRISTOL, CONN.
Story with pictures and drawings of switchboard Mr. Voss built.
The following bulletins on POWERSTAT light dimming equipment are also available without charge:
Non-Interlocking Types
Interlocking Types
Packaged Assemblies
Positioner Controls
NAME
ORGANIZATION
ADDRESS
CITY ZONE STATE

LIGHTING ENGINEER WANTED

To design and supervise installations. Permanent, responsible position. Top salary. Pittsburgh Outdoor Adv. Co., 2610 Fifth Ave., Pittsburgh 13, Pa.

SITUATION WANTED

Young Lighting Specialist, experienced in sales and layouts of commercial, residential, industrial lighting. Familiar with lamp sales procedure. Address Box 157, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

LIGHTING FIXTURE SALESMAN

Active salesman needed for Ohio to represent one of the largest manufacturers of slimline, fluorescent and incandescent lighting fixtures. Nationally known company located in the East. Strict wholesale policy. Must have following of electrical jobbers and thorough knowledge of lighting fixture business. No objection to the selling of non-conflicting lines. Address Box 158, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

REPRESENTATIVES WANTED

Long established custom-built manufacturer seeking experienced lighting specialists to call on architects, engineers and appointed distributors to offer complete line of Exits and Directionals, Holophane Controlens and designs to specification. Resume confidential. State territory now covering and manufacturers represented. Address Box 159, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y., or if attending coming 4th International Lighting Exposition in Cleveland, see Mr. Benjamin Schaefer, Hotel Statler, May 7, 8 and 9.

LIGHTING DESIGNER WANTED

Established medium size New York manufacturer of custom-built lighting equipment has opening for top flight lighting engineer who possesses administrative ability and production —sheet metal experience. (Unusual opportunity.) Salary commensurate with qualifications. Resume will be confidential. Address Box 160, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

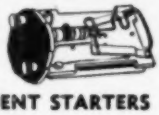
LIGHTING SALES ENGINEERS WANTED

With following among wholesalers and architects. Territories open are Oklahoma, Texas, Louisiana, and Mississippi. To handle a quality line of engineered fluorescent and slimline fixtures which are well accepted and competitively priced. Must have 5 years or more practical experience. Give complete details. Replies held in strict confidence. Address Box 161, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

WANTED—LIGHTING EQUIPMENT ENGINEER

To develop and carry through a program for the design, manufacture and installation of a central lighting system for underground operation, mines, etc. Broad experience in lighting system development through layout, detail design, model construction and testing is required. Knowledge of manufacturing methods and government mine regulations and standards is desirable. Electrical or Illuminating engineering design or equivalent is required. Location: East. Age: 30 to 45. Salary: $10,000 to $12,000. Address Box 162, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

Sentry
(AIR-THERMAL)



FLUORESCENT STARTERS

AIR-THERMAL *features*

- Approximately 50% longer lamp life —because lamps are lighted with one starting cycle
- Operate at 90-125 line volts
- Operate at 0°F.-140°F.
- Operate on AC-DC

other features

- Automatic cut-out (no-blink)
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Guaranteed for two years.
Technical literature available.

INDUSTRIAL STARTER CORP.
6 Pell St., New York 13, N. Y.

A 50-TON CRANE for 1 new bulb!

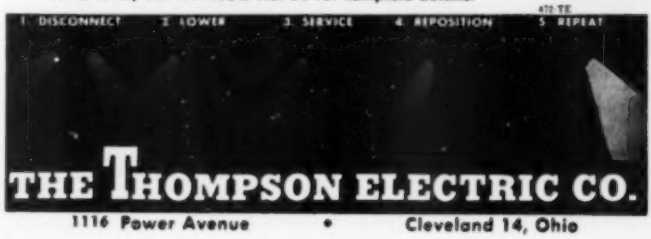
Lower your lights for lower maintenance costs

Using two men and a crane to maintenance overhead lights is like sending *two men and a tractor to carry a wrench.* For efficient servicing of high-bay lights, **there is no faster, safer means than THOMPSON disconnecting and lowering hangers!**

Lighting maintenance costs come down with the lights, and new safety records are set by service crews when **THOMPSON** hangers are installed. Simple manual control is exercised from floor level.

Don't service your overhead lights by costly or hazardous means . . . **install THOMPSON hangers and save money!**

Write today for CATALOG No. 50 for complete details.



THE THOMPSON ELECTRIC CO.
1116 Power Avenue • Cleveland 14, Ohio

it tells you...

WHEN group replacement is profitable and when it isn't

WHAT is your most profitable cleaning cycle

WHERE and HOW you can eliminate 83% of your lamp burnouts

WHY you can replace six lamps for what it now costs you to replace one

MAIL THIS COUPON TODAY

Get the low down, now, when it profits you most. The facts to fit your operation are in this Champion File Folder — yours for the asking.

CHAMPION LAMP WORKS

LYNN, MASSACHUSETTS

Please mail your *Free File Folder L* on planned cleaning and group replacement, at no cost or obligation to:

Name ..... *Position* .....

Company .....

Street .....

City ..... *State* .....

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ORNAMENTAL
LIGHTING FIXTURES

for
Churches
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Banks
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Schools
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Hospitals
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Buildings

Send for our latest catalog showing hundreds of lighting fixtures and lanterns, fabricated of genuine bronze, wrought iron, and stainless steel by Cincinnati's Metalcraftsmen.

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Decorative Lighting
CHICAGO

for sale: a rare jewel

The crest on your fine motorcar is a symbol of value beyond compare. The famous Squibb drug trademark is what they so aptly called *"The Priceless Ingredient"*. In the lighting field, the trademark you see here in this advertisement is the most precious thing you buy when you do business with SOLARLITE . . . your assurance of lighting fixtures designed for your job, of flawless engineering to answer your particular problem . . . your insurance of *solid satisfaction* every step of the way. *How can we help you?*

Solar Light Manufacturing Co.
1357 S. Jefferson St., Chicago, Illinois

When attending the Fourth International Lighting Exposition . . .

VISIT OUR SUITE AT THE HOLLENDEN HOTEL
(EAST SIXTH STREET AT SUPERIOR)

FLUORESCENT EQUIPMENT AND MANUFACTURING CO.
Manufacturers of Femco Lighting Fixtures
FLUORESCENT — INCANDESCENT

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F35 series available
in slimline and fluorescent

F35A: corning new curved alba-lite
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This is one of an extensive line of finer lighting fixtures. **solux** means better engineering, better design, better production.

solux
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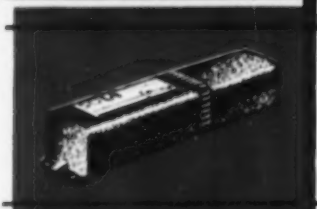
SOLA

designed in the tradition of Sola engineering leadership



SOLA "Sequenstart" Ballasts

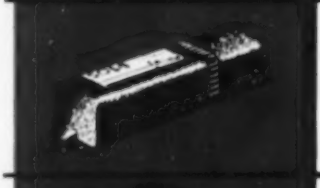
for instant-starting Slimline Lamps

This is the ballast (incorporating Sola's patented Sequenstart circuit) that Sola Electric Co. introduced to the lighting industry in 1948. Another famous Sola "first". Complete electrical and mechanical specifications on Sequenstart and also single lamp ballasts for instant-starting lamps are described in new bulletin CPFL-151.

SOLA Cold Cathode Ballasts

for 93 inch, 25 mm diameter cold cathode lamps

This is the ballast that has become the universal standard for cold cathode lighting. It incorporates many Sola "firsts" including pressed-in-core construction, the patented constant-wattage circuit and the patented ventilated capacitor compartment. These features are also available in Sola slimline ballasts. Complete electrical and mechanical specifications on cold cathode ballasts are described in new bulletin CPFL-152.



SOLA Pre-Heat Lamp Ballasts

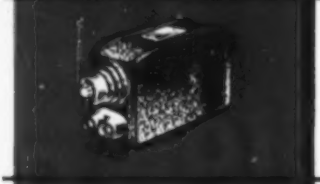
for 2-85/90 watt 60T17 lamps

Here is a newly designed two-lamp ballast for the 85/90 watt pre-heat lamp, the only ballast of this type available with the Sola ventilated capacitor compartment. This feature has been added to extend ballast life, by reducing the ambient temperature of the capacitor. It is engineered to the high standards of performance you have come to associate with every Sola product.

SOLA Mercury Vapor Transformers

for indoor and outdoor lighting

A new application for the patented Sola Constant Wattage Principle brings to the lighting industry design and construction features that are unique on Mercury lamp auxiliaries. The circuit design assures positive starting over a wide range of primary voltages, eliminating the necessity for primary taps. It also maintains constant light output, lamp wattage, and lamp operation, despite low line voltage conditions. Write for new bulletin CMV-157.



SOLA Luminous Tube Transformers

for the electric sign industry

These transformers incorporate many of the famous Sola "firsts": pressed-in-core, universal mounting dimensions, moisture sealed porcelain bushings, compact case dimensions, balanced core-and-coil design and others. Material restrictions have cut back production, but each transformer produced is the identical high quality unit that has always distinguished Sola products.

You are invited to see the latest technical advances in lighting transformers demonstrated at the Sola booth, Fourth International Lighting Exposition, Cleveland, May 6, 7, 8 and 9.

SOLA *Lighting* **TRANSFORMERS**

The transformers described are made under one or more of the following U. S. patents: 2,143,745; 2,212,198; 2,346,621; 2,489,245; 2,552,111; 2,582,291 and Patents Pending.

Transformers for: Constant Voltage • Fluorescent Lighting • Cold Cathode Lighting • Airport Lighting • Series Lighting • Luminous Tube Signs Oil Burner Ignition • X-Ray • Power • Controls • Signal Systems • etc. • SOLA ELECTRIC CO., 4633 W. 16th Street, Chicago 50, Illinois

To get efficient fluorescent lighting ... insist on *This Shield on your ballast*

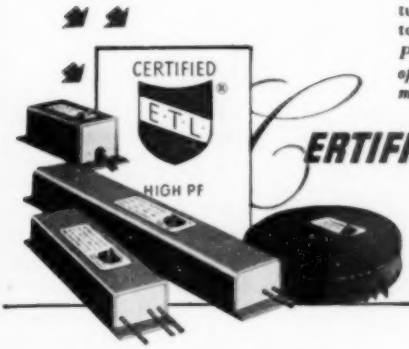
There's more to satisfactory fluorescent lighting than lamps and a reflector. There's always a ballast in the fixture . . . and the way it performs determines whether you'll get *full lamp life, rated light output* and *satisfactory performance.*

Only CERTIFIED BALLASTS carry the shield that assures best lighting. That's because CERTIFIED BALLASTS are made to precise specifications, then tested by Electrical Testing Laboratories, Inc., which certifies they conform to these high standards.

There's no excuse for inefficient, unsatisfactory fluorescent lighting when CERTIFIED BALLASTS are available.

Be sure every fixture you get has CERTIFIED BALLASTS . . . the ones with the shield.

● Complete information on the types of CERTIFIED BALLASTS available from each participating manufacturer may be obtained from Electrical Testing Laboratories, Inc., East End Ave. at 79th St., New York, N. Y. *Participation in the CERTIFIED BALLAST program is open to any manufacturer who complies with the requirements of CERTIFIED BALLAST MANUFACTURERS.*



CERTIFIED BALLAST MANUFACTURERS

Makers of Certified Ballasts for Fluorescent Lighting

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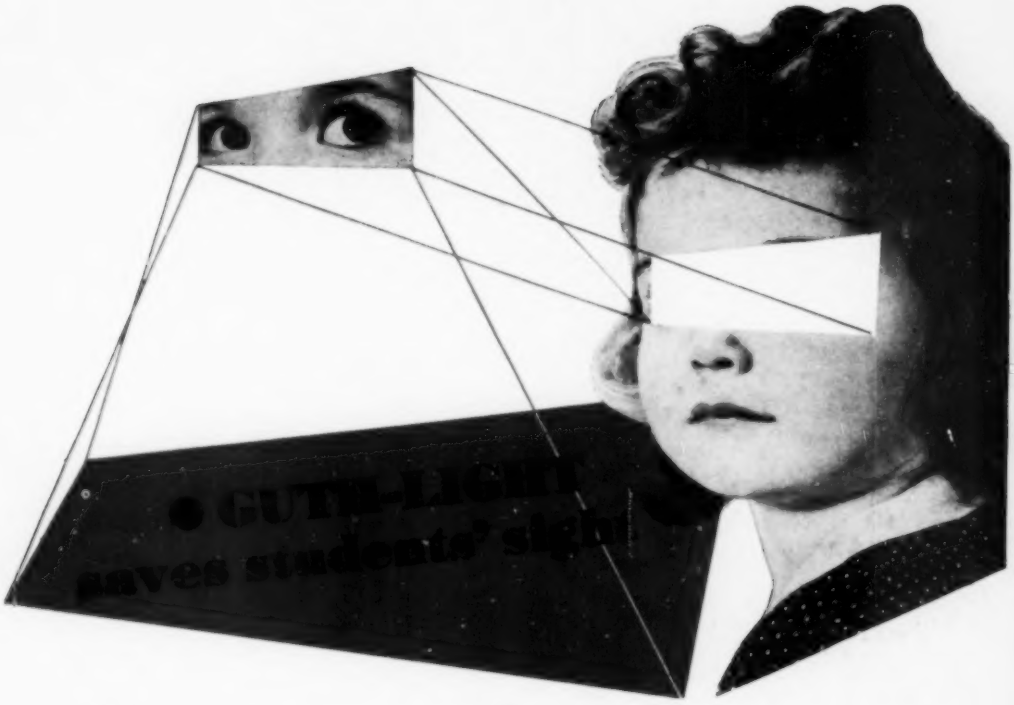

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Balanced lighting — 40% up and 60% down. Louvres hinge to either side for easy cleaning. 300° WHITE PERMALUX finish.

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